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The Growth of Fiber Glass

The uses of fiber glass are legion; they are increasing day by day, often in competition with well-established materials like steel, aluminum and wood. Because of its rapid, and sometimes haphazard, growth, the fiber glass industry has had to pass through a trial-and-error stage of development. It is now entering a new, more mature stage—one requiring continued serious research and development.

There is still much to be desired here. A great amount of research is being carried on by fiber glass and resin manufacturers, weavers, and some fabricators. The manufacturers have established their own standards, and have made serious efforts to broadcast them within various industry groups. So far, though, no standards have been accepted by fabricators on an industry-wide basis.

This leaves room for the manufacture of inferior products which, in the case of the boat industry, for example, could lead to a fatal accident because of unseaworthiness or lack of sufficient buoyancy. It is therefore time for members of the fiber glass industry, especially the many fabricators around the country, to become more keenly aware of the heavy responsibility on their shoulders. If they are to succeed in continually enlarging their markets by making products in direct competition with other basic materials, they must back up these products with the guarantee of sound research, development, and, above all, reliable standards and specifications.

Our special thanks to each of the fiber glass manufacturers for their help in gathering material for this special issue.

The Fiber Glass Market

by Norman F. Heydinger

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The Silver Anniversary of fiber glass as a commercial product will soon be celebrated. Although fiber glass has been in use for almost a generation, and in spite of the fact that it is now generally accepted as an engineering material in its own right—not as a substitute—there still persists an aura of glamor about this product. Such descriptive terms as "magical," and "wondrous" are still frequently used. Undoubtedly, one of the primary reasons for this exalted position of fiber glass is the constant uncovering of new and often dramatic applications, particularly in the textile markets, rather than in the insulation or filter markets where fiber glass made its initial entry in the latter 1930's.

These rapid strides in textile glass fibers are reflected in their increasing share of total glass fiber sales (all products) over the years. From 1950 to 1960, inclusive, textile glass fibers have approximately doubled their share of total glass fiber sales to about 26 per cent on a dollar basis. Moreover, continued growth is expected to increase this ratio to about 33 per cent by 1965. In this same 1950-60 period, industry textile glass fiber shipments soared from 22 million lb. to 154 million lb., an increase of 600 per cent.*

This excellent growth does not mean that brief periods of leveling off have not occurred. For example, 1960 marked the first year since 1947 in which textile glass fiber shipments failed to exceed the previous year. A number of factors contributed to this condition, including *(1)* an exceptionally good year in 1959, *(2)* excessive inventories in the distribution pipelines, *(3)* a faltering boat market, and *(4)* an economic recession. Coupled with these factors, a huge expansion program by fiber glass manufacturers was bringing capacity on stream during 1960 just when the markets were weakening. The bright side of this seemingly dark picture is that excess capacity is a necessary antecedent to a period of market expansion. This imminent resumption of growth is expected to accelerate in the latter half of the 1960's.

The textile glass fiber major market breaks down as decorative, electrical, industrial, reinforced plastics, reinforced nonplastics, and insect screening. Most of this glass is shipped directly from the producer to industrial users, although over 40 per cent is processed through

*Textile Economics Bureau.

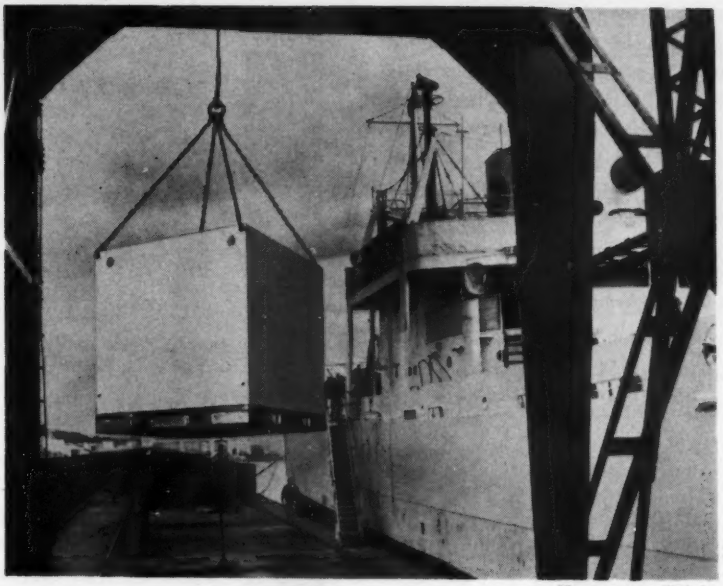


Photo courtesy Heil Co.

Representative of the growing end-use market for textile glass fibers is this reinforced plastic cargo container for use in liquid freeze operations which eliminate the need for external refrigeration.

weavers who make broad and narrow fabrics including woven roving.* (*Roving* refers to strands with little or no twist, whereas *yarn* means strands which are twisted and can also be plied.)

DECORATIVE

This is a key market for fiber glass. With over 10 million women employed outside the home, the demand is increasing for marquisettes and draperies which are easy to launder, must be durable, shrinkproof, and fire-safe; and they must not stretch, rot, or deteriorate.

Fiber glass sales in 1959 for drapery fabrics were approximately 20 million lb. which represented less than 5 per cent of the total drapery market, indicating the tremendous potential for fiber glass. In 1960, even with the recession, decorative fabric sales were 50 per cent higher than in 1959, and for the first time, the number of decorative looms operating in weavers' plants exceeded industrial looms—2,137 vs. 1,919, as of July 1. With the sharp upturn in new households anticipated for the late 1960's, continued good growth is in store for fiber glass. This should result in glass sales considerably above the expected 50 million lb. estimated for 1965.

A recent application of decorative fabrics is the facing on a molded fiber glass headliner being installed in one model of the 1961 Rambler. This headliner market has a tremendous potential, considering a 6-million car production year, as well as other modes of transportation.

Of interest, too, is the recent announcement that the abrasion resistance of fiber glass yarn has been improved to such an extent that glass fabrics will be used in upholstery applications in the not-too-distant future.

*See *Fiber Glass and the Weaver*, page 322.

ELECTRICAL

This substantial market, excluding reinforced plastics, is served by various fiber glass products—broad woven, narrow woven, braided sleeves, nonwoven tapes, and yarn. The over-all electrical market will continue to expand as the uses for electricity multiply and the trend towards miniaturization and higher operating temperatures of electrical equipment increases.

Broad woven goods are heat treated, varnished, and slit into tapes or die-cut into various shapes for use in motors, generators, etc. Narrow woven goods (tapes) have countless applications, in transformers, armatures, and coil windings. Originally, asbestos and cotton dominated this market, but glass has now replaced most of the asbestos and a considerable portion of the cotton. (There is also an increasing use of tapes in reinforced plastics for nonelectrical applications such as boats.)

For sleeving and tubing applications incorporating textiles, fiber glass braid has taken over more than 90 per cent of the market. Extruded products including silicone rubber and teflon are expected to make moderate gains, particularly in the military market. (An interesting non-electrical application here involves repairing broken Little League baseball bats. Kits are sold which contain a braided sleeve, epoxy resin, and the other necessary ingredients.)

Unidirectional nonwoven glass tapes are used in large electrical equipment such as the banding medium for armatures and strapping for transformers. Considerably reduced labor costs accrue when glass is used instead of steel in these applications.

In the wire and cable industry, nonmetallic sheathed cable is the largest user of fiber glass (as the outer braid) and consumed almost 8½ million lb. of glass

in 1959. Thermoplastics, however, pose a serious threat to fiber glass in this market. In another area, magnet wire (Class H temperature applications) uses fiber glass (yarn) insulation exclusively, but developments in thermoplastics threaten glass in all temperature classes, including the high temperature. Fiber glass is also used in relatively small quantities as wire insulation in the power, communications, appliances, aircraft, missile, and automotive fields.

In summary, *the electrical market is exepected to level off at about 20 million lb. of fiber glass annually for the foreseeable future.*

INDUSTRIAL

This category includes such end uses as filtration, coated fabrics, nonelectrical cordage, hose and belting.

Until the advent of silicone treatment several years ago, abrasion problems limited the use of fiber glass cloth in the bag filtration market. Now the only limitations are contact with fluorine chemicals and temperatures above 500°F. The glass bag maintains a 99.5 per cent efficiency under all load conditions. In contrast, the electrostatic precipitator maintains a 98.5 per cent efficiency under the most optimum conditions, and under heavy load conditions can drop as low as 50 per cent.

The carbon black industry was the first major user of glass bags and now has about 100,000 in use around the world. The fastest growing current market for these bags is the cement industry (some 25,000 bags are now in use) and up to 80 per cent of added capacity is expected to utilize them for filtration. Potential large markets include ore refining, chemical processing, gypsum, food processing, and electric power generating (coal) industries. *The bag filtration market should consume about 4 million lb. of glass by 1965.*

Primary markets for coated fabrics are interior linings for aircraft and draperies in schools. Price competition is a major problem for fiber glass in the latter application. In hose and belting, where exceptional strength is required, fiber glass is frequently used to reinforce the base material.

REINFORCED PLASTICS

In reinforced plastics (RP) we have the largest volume market for fiber glass, and also the one with the greatest growth potential. Hardly a day passes without the advent of a new application in this broad and dynamic industry. Major categories include construction, transportation, process equipment, and miscellaneous uses.

Construction

The largest segment of this market is served by corrugated and flat sheet panels which achieved a volume in excess of 80 million sq. ft. in 1959, with 10 producers accounting for about 75 per cent of the market. Applications include industrial skylights, patios, awnings, garage doors, fences, auto canopies, shower doors, room dividers, and a multitude of others. Several pertinent trends are developing in this market.

TABLE I

ESTIMATED SHIPMENTS OF RECREATIONAL BOATS BY TYPE, 1958
Based on Product Survey by NAEBM, and on OBC Estimates

1. Lighter weight panels.

2. Flat panels, currently about 10 per cent and expected to reach 25 per cent by 1965.

3. Acrylic-modified polyester resin to improve weathering. All-acrylic RP panels have been on the market for several years but have not attained large volume to date.

4. Steady reduction in number of manufacturers.

5. Product guarantees. At least one producer has a 15-year guarantee.

The market is expected to increase to about 150 million sq. ft. by 1965, excluding panel usage in sandwich components, which are expected to become a major factor in construction during the 1960's. The largest share of fiber glass sandwich components will combine two flat sheets of reinforced panel with a core material. In addition, there will be considerable volume in sandwich construction with fiber glass skins in laminate form such as those embodied in the "Monsanto House Of The Future," Disneyland, where ten plies of woven roving form the outer skin. Several companies are producing these sandwich panels. Although up to now their installations have been primarily in schools, churches, and commercial structures, the sandwich panels are expected to appear in the residential market as well. In-

terior partitions (nonsandwich) in homes now are leading in this direction. By 1965 sandwich panels will probably use several million pounds of fiber glass.

Other promising construction-type markets include rain-carrying equipment (gutters and downspouts), bathroom accessories, laundry tubs (about 200,000 singles are being produced annually), swimming pools (about 3000 RP residential pools were constructed in 1959), cooling tower components, and concrete structural forms.

Transportation

Aircraft and missile applications consumed almost 10 million lb. of fiber glass during 1960, using both cloth and roving.* The cloth was used in honeycomb form for strength, leeched for high-temperature application, or prepregged for hand layup. Prepregged, or preimpregnated, refers to fiber glass in strand or cloth form which has been impregnated with resin prior to, rather than as, an integral part of the molding operation. Prepregged glass is partially cured ("B" stage) at the time of use. Here, roving was prepregged for filament winding, chopped for molding compounds, or leeched for high-temperature applications.

The biggest breakthrough will come in filament winding where, in combination with epoxy resins, roving consumption is expected to soar into the multimillions of pounds by 1965 for rocket motor cases, spheres, and propellant tanks where strength-weight ratio is critical.

Fiber glass in civilian aircraft comprised about 10 per cent of the aircraft and missile total poundage in 1960, and will grow at a considerably reduced rate compared with the military aircraft, particularly the space program. A great deal of work has been done, however, on developing an all-RP airplane.

The automotive field is another key market for RP as we look to the future.† In this category we include passenger cars, motor trucks, and buses. The average 1960 model passenger car contains some 22 lb. of plastics (RP, 3 lb.), double the 1954 amount. This trend to plastics will accelerate in the next 10 years, with RP getting its share of this market.

We anticipate increased RP participation in limited-production models—currently experiencing a strong uptrend—but not in the mass-volume makes represented by the standard Ford or Chevrolet passenger cars. The primary reason for this is that metal stampings can be produced at a considerably faster rate than molded products which involve "curing" time. Futhermore, limited-production models can use RP molds which cost a fraction of metal dies.

In the truck-trailer and tank truck fields RP will play a major role, not only because limited-production volumes are the rule rather than the exception, but also because the weight savings of RP directly increase the payload and because these benefits are coupled with the anti-corrosive properties and other basic advantages of RP.

Interior liners and support ribs in refrigerated truck-trailers are already a fact, and this could well lead to RP roofs and sides. In the tank truck field, the pioneering Heil Co. introduced an RP bulk milk pickup tank in 1953. One of their current model tanks is integrally molded in one piece combining layers of glass cloth and mat with balsa and stainless steel.

RP will also play a big part in containerization which is closely allied with the truck-trailer, railroad, and marine industries. Other transportation items using RP include aerial booms mounted on trucks and used to facilitate working on electrical high wires without danger of "hot" lines,‡ three-wheeled Cushman Mailsters with RP windbreaks, U-Haul trailers, and tractor parts.

Process Equipment

Here we consider *(1)* tanks, ducts, hoods, stacks, fans, scrubbers, etc., and *(2)* pipe. All have in common the problem of corrosion from chemicals or other ingredients.

Included in the tank category are water conditioning units representing a fast-growing industry for the residential market. In 1959 about 750,000 units were installed, representing a 37 per cent increase over 1958. At the beginning of 1960, 4.3 million homes were equipped with water conditioning units, a 7 per cent total market penetration.

Over 10 per cent of the units currently being produced are RP, and this share promises to increase as more manufacturers take steps to avoid the corrosive action of the brine used in regeneration of the water conditioning crystals. A filament-wound tank has potential for taking a good share of the market. (Filament winding is prepregged roving wound under controlled tension around a mandrel to achieve directional strength and a high strength-weight ratio.)

Probably more research, written reports, and glowing promises have been associated with RP pipe than any other RP product, without achieving anywhere near the desired results, at least to date. The primary markets are the oil, gas, and chemical industries. Price and product problems have plagued the RP pipe producers, but they persist and keep their sights hopefully on the large potential.

Miscellaneous Uses

The remaining RP markets are so diversified that they have been grouped for convenience under this general heading, which is in no way intended to imply that these end uses are unimportant, currently or in the future.

Pleasure boats are, and have been for the past several years, the most widely discussed of all fiber glass markets. And rightly so from the standpoint of RP, since they alone consumed about 20 per cent of total textile glass fiber shipments in 1960. The most salient developments in pleasure boating in recent years have been *(1)* the trend to fiber glass (from 10,000 RP outboards sold in 1954 to 155,000 in 1960), *(2)* the trading up

*See *Fiber Glass in Space*, page 318.
†See *Fiber Glass is Rolling*, page 337.
‡See THE GLASS INDUSTRY, page 203, April 1961.

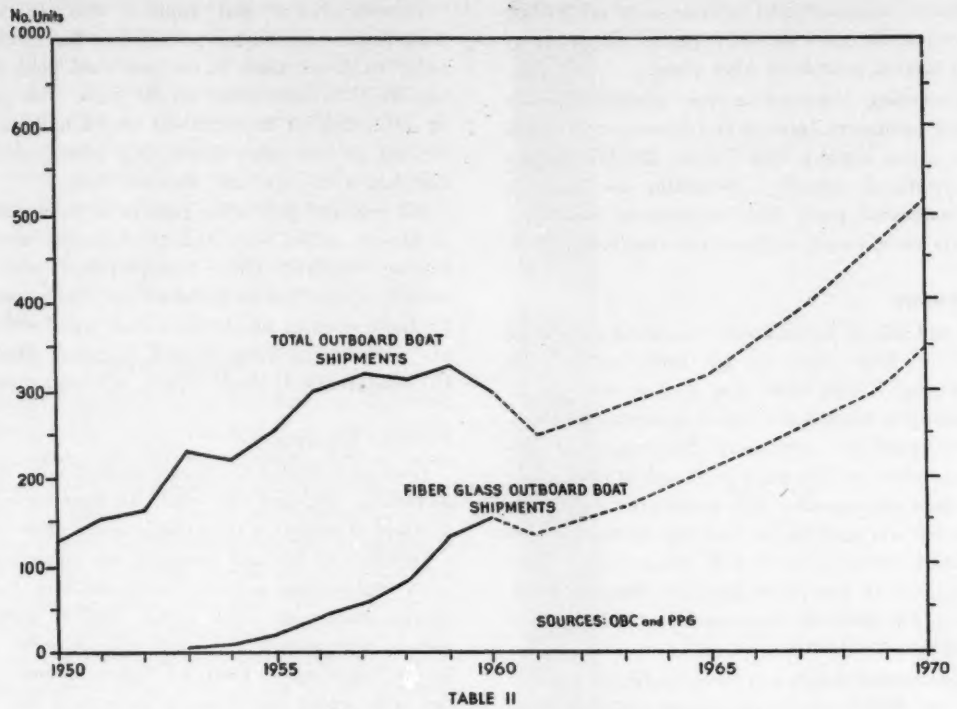


TABLE II

OUTBOARD BOAT SHIPMENTS TO DEALERS
Total vs. Fiber Glass, 1950-1970

both in horsepower and length, and *(3)* the increasing number of large industrial corporations entering production, with a consequent drastic reduction expected in the number of boat producers over a period of the next 5 to 10 years.

Table I (page 314) shows the breakdown of pleasure craft shipments in 1958. Of overwhelming importance are outboard boats, which range from 9 to 22 ft. in length and have been the backbone of the recent boat boom.

Table II shows the historical and projected unit shipments of total outboard boats and RP. The RP data are based on their reaching, by 1965, 65 per cent penetration of total outboard boats shipped, and retaining that share through 1970.

Concerning inboard boats, ranging in length from 18 ft. up, our estimate of RP vs. total inboard shipments in 1959 is 15 per cent. This market promises a bright future for RP because "trading up" is placing more customers in this size category, the poundages of glass per unit are considerably greater than in outboards, and as a result, the share of RP is expected to reach 40 per cent by 1965.

Sailboats are a natural for RP, with the 1959 shipment ratio of 40 per cent expected to reach 90 per cent by 1965, coupled with a 60 per cent increase over 1959 in the number of sailboats shipped. These data include the "sailfish" type of craft.

Military boats, insofar as RP is concerned, are being produced by two or three molders operating under the favorable decision that all U.S. Navy boats under 50 ft.

TABLE II (Supplemental Data)

	Total Outboard Boat Shipments To Dealers (000 Omitted)	Number of Fiber Glass Boats (000 Omitted)	Per Cent Fiber Glass
1950	131	.....	.....
51	154	.....	.....
52	164	.....	.....
53	231	5	2
54	223	10	7
55	258	20	8
56	302	40	13
57	320	55	17
58	316	80	25
59	329	130	40
60	300	155	52
61	250	135	54
65	318	205	65
70	520	340	65

be of RP construction. A number of 40-ft. utility boats have already been produced. All indications point to a steady market for RP in the years ahead.

In RP electrical applications, the major volume of glass goes into flat sheet laminates which are used in rotating equipment, transformers, switchgear, and electronics applications. Metal (copper) clad laminates for printed circuits are taking an increasingly large share of this market. Other RP products for electrical application are rods, tubes and a wide variety of small molded parts made from premix (a compound containing chopped fibers, resin, filler and catalyst.)

There is an expanding RP market in housings which include outboard motor shrouds (which are threatened by thermoplastics), lawn mower housings, cabinets for TV, radio, and, phonographs, marine battery boxes, and land-based radomes. There is no limit to the possibilities in this field.

Another rather spectacular market for RP in recent years has been seating. The utilitarian—and frequently colorful—RP chairs have become a familiar sight in passenger terminals, waiting rooms, hospitals, bowling alleys, and school classrooms. Sales of RP seats in 1959 approximated 1.5 million units with 75 per cent destined for institutional markets. Thermoplastic chairs are being promoted with moderate success by one of the larger seating manufacturers.

The sporting and recreational market* can only increase in the years ahead as leisure time and income both become more plentiful. (Fishing rods represent the highest degree of saturation for RP—almost 100 per cent.) Covering a wide variety of items, this market is expected to double by 1965. For the RP market including planters and related items, the outlook is good except for planters where thermoplastics are making inroads.

Tools, dies, jigs and fixtures are important in the metal fabricating industry. The largest markets are automotive and aircraft where, because of the complex shapes required, the advantages of economy, speed, light weight, and dimensional stability of fiber glass can best be realized. Fiber glass cloth is used in this market, which is expected to more than double for RP by 1965.

A growing stream of new products continuously emerge from Research and Development to expand the applications for RP. A partial list of old and new miscellaneous applications include hammer handles, safety hats and caps, welding shields, electric light poles, paper roll cores, buoys and filament-wound chains for marine and other applications, and one of the most recent—two tiny parts in the movement of an electronic transistorized wrist watch.

In summary, reinforced plastics consumed about 75 million lb. of fiber glass in 1959 and are expected to more than double this amount by 1965.

REINFORCED NONPLASTICS

The major segments in this category are abrasives, paper and tape, roofing and pipe wrap, wallboard and plaster, and miscellaneous uses.

In the early 1950's the abrasive industry began using a phenolic resin as the bond in grinding wheels. This led to reinforced grinding wheels using cotton. In 1953 glass fabric reinforcement was tried successfully and usage has grown rapidly ever since. Glass-reinforced wheels operate at speeds up to 18,000 rpm, thus increasing productivity commensurately.

A wide variety of waterproof reinforced papers are used in construction, by industry and on the farm. Glass fibers are used in over half of such paper. Plastic films are an increasing threat to this product.

The primary uses for reinforced paper tape are in *(1)* the manufacture and *(2)* the sealing of corrugated shipping containers. In the former, glue threatens fiber glass growth for the long pull. In the latter, the 2-strip sealing method—top and bottom—made possible by reinforced tape has lent considerable impetus to the use of this method, promising excellent growth for fiber glass.

Pressure-sensitive tapes are used in a host of applications, primarily, however, in the packaging field where they are referred to as strapping tapes for replacement of steel wire and bands. Use of these tapes has doubled in the past 5 years and continued good growth is indicated despite competition from other non-cellulosics.

Fabric reinforcements (all materials) in roofing repair and waterproofing amounted to 20 to 25 million sq. yd. in 1960. Of this total, glass scrim cloth was a major factor and is expected to continue increasing at the expense of cotton, jute, and glass bonded mat. Some architects are beginning to specify scrim cloth rather than felt in built-up roofing (new construction). This is an abrupt break with the past and has interesting possibilities. A recent development is the Flintkote roofing program which employs a gun for spraying an asphaltic compound along with a reinforcing stream of chopped glass roving for new construction. This program is being field tested and holds good future promise.

In the underground pipewrap industry, glass bonded mat contains glass yarn in parallel reinforcement, and in wall construction, wallboard (dry wall) usage is increasing at the expense of plaster. There has also been a steady increase in the use of chopped glass roving in the wallboard to improve nailing characteristics and to provide a better fire rating. Glass reinforced plaster is being sold by one major gypsum company.

Developmental work has progressed in reinforced concrete and reinforced ice (for such applications as airport runways in the far North). Finally, glass fibers are being used for reinforcing false teeth plates and fillings for teeth. But the use of fluorides in water is expected to cut sharply into this fiber glass market!

INSECT SCREENING

During 1959 some 680 million sq. ft. of insect screening was sold. Over-all growth of this market will be moderate in the next 5 years and more rapid in the latter 1960's. Although construction will increase, offsetting factors will include the continuing trend to air conditioning plus a declining replacement volume as the galvanized product loses market. Last year fiber glass took about 15 per cent of the market. This share should climb to 50 per cent by 1965 as the consumer becomes more aware of the relative benefits of this product compared with competitive materials. A recent development in fiber glass insect screening is a 10-year guarantee being offered by the largest producer.

*See *Fiber Glass in Recreation*, page 342.

Fiber Glass in Space

By Paul L. Layton

National Representative-Aircraft and Missiles Markets
Owens-Corning Fiberglas Corporation

In its short history, fiber glass has found its way into many areas of our society, including that of space exploration.

It is obvious that man's steady probing into the new world of outer space will increasingly require materials of the greatest versatility. Structural materials that will resist the higher and higher temperatures generated by rocket engines—some now reach 15,000°F—are currently in heavy demand. So are materials that are as strong as, or stronger than metals, but lighter in weight. Fiber glass itself stands up well under high temperatures. Combined with resin as a laminate, it meets many of the strength requirements of the defense program.

Rockets and Missiles

But because fiber glass for structural applications must be combined with plastic resins and coatings, its inherent resistance to high temperatures is sacrificed up to 60 per cent by the failure of the resin to stand up under comparable temperatures. Accelerated research programs are under way to develop resins which, when combined with fiber glass, will not deteriorate nor delaminate when subjected to the 5000 to 15,000°F temperatures which are built up and maintained for only a matter of seconds in rocket fuel combustion chambers. It is encouraging to note that recovery of a Polaris missile on a test run showed that the FRP (fiber glass reinforced plastic) heat shield had maintained structural integrity at 13,000°F.

Resistance to cryogenic temperatures as low as –400°F is required in rockets and missiles utilizing liquid oxygen and hydrogen as part of the propellant fuel. Here fiber glass reinforced plastic combined with superfine glass fibers is successfully used as insulation to keep component parts from freezing. FRP is also used in the rocket motor case as a direct replacement for steel. Here, too, it is applied as insulation to protect the outside of the case from the effects of aerodynamic heating.

One space expert has estimated that by 1970 one-half of the structural weight of U.S. missiles and space vehicle systems will be fiber glass reinforced plastic. This could prove to be an extremely accurate prediction, at the rate that fiber glass is being consumed—between 5 and 10 million lb. of reinforced plastic went into missile and rocket production in 1960, according to unofficial statistics.

Consider the U.S. missile program in its current status. You will find fiber glass in one form or another in almost every missile system now in operation or contemplated. Fiber glass reinforced plastic is applied in strategic missiles Minuteman, Polaris, Sky Bolt, Quail, Atlas, Titan and Thor; in tactical missiles Pershing, Sergeant, and Shillelagh; in anti-aircraft missiles Bomarc, Hawk, Redeye and Tartar; in antimissile missiles Nike Zeus and Mauler, and in air-to-air missiles Falcon and Eagle.

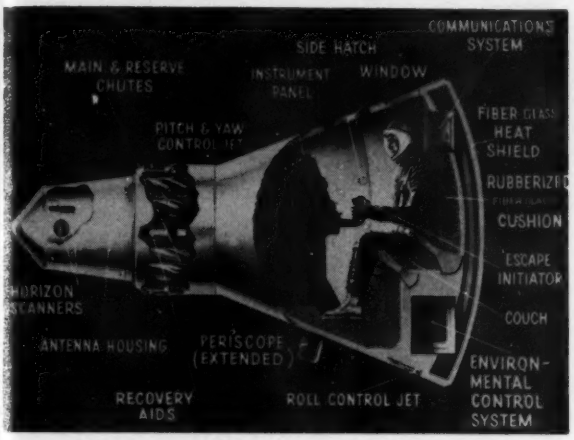
The Air Force is experimenting with an FRP "skirt" as an extension of its rocket nozzles to provide better thrust for desired altitudes. Light weight and heat resistance are imperative for this application. Scale models have been tested successfully at 35,000-lb. thrust, 150,000-ft. altitude, and at temperatures as high as 6000°F.

In the walls of the Titan underground silo which houses the great missile before launching, there are 100,000 lb. of fiber glass insulation for sound and vibration dampening.

Cushioning pads of glass fiber are being used to line combustion chambers of solid propellant missiles. As the propellant grain expands in warm weather, the padding absorbs the expansion, thus keeping the grain intact and does not permit it to crack. The resistance of the glass to high temperature and deterioration make it ideal for this application.

Satellites

In satellites, probably the best known fiber glass application in the entire space program is in the Mercury Capsule which carried the first American 115 mi. into space, and will soon transport an astronaut into orbit and back again. The capsule contains an FRP heat shield and FRP-rubber astronaut's "couch."



The Mercury Capsule put first American into space.

OSO, the Orbiting Solar Observatory satellite developed by the National Aeronautics and Space Administration, and due to be launched this Summer, contains three FRP nitrogen bottles mounted on extended "arms" of the 350-lb. axle-spinning space craft. These bottles are designed to increase the moment of inertia of the main body (wheel) of the craft for gyroscopic stability. The gas in the bottles is fed back to the wheel and fired from jets there.

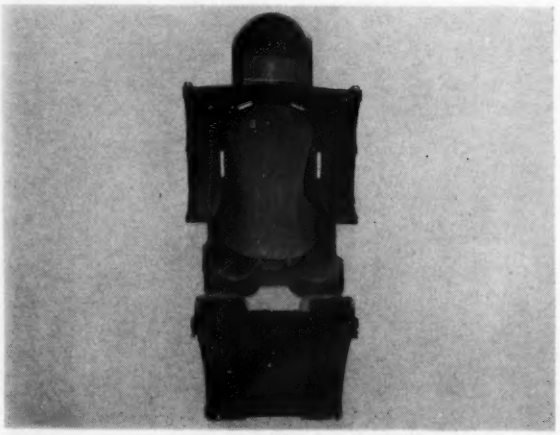


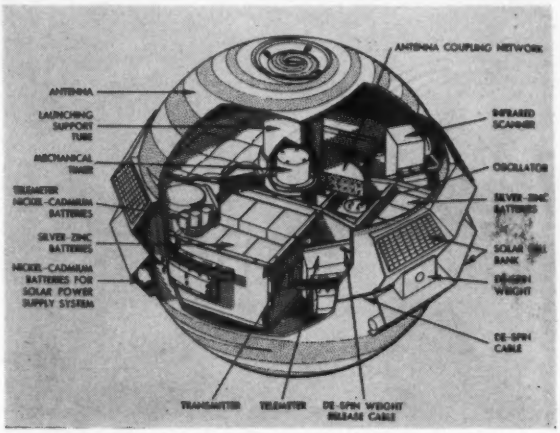
Photo courtesy McDonnell Aircraft Corp.

Close-up of fiber glass astronaut couch.

Filament-wound FRP rocket motor cases were produced for the launching of Echo (balloon communications satellite), Tiros (weather communications satellite), and Pioneer (solar satellite), all currently in orbit. In addition, Courier, the Department of Defense 500-lb. satellite now in orbit, contains an FRP solar battery shell. The battery is designed to produce electric power from solar energy. The Navy's Transit, a 265-lb. experimental navigation satellite orbited in 1960, is constructed of two FRP shells with a honeycomb filler, has an FRP tube connecting compartments and supporting the instrument tray, and contains a layer of fiber glass and aluminum foil to minimize temperature changes in flight.

Meteoroid Protection

Looking further into the future, there is the possible impact of meteoroids upon manned space craft. This would require wall construction which would localize any punctures to minimize the danger of craft failure. Dynamic tests have been conducted with this possibility in mind. A phenolic-glass fiber honeycomb structure remained virtually unaffected by pellet penetration throughout the course of these tests.



This Transit navigational satellite orbited in 1960.

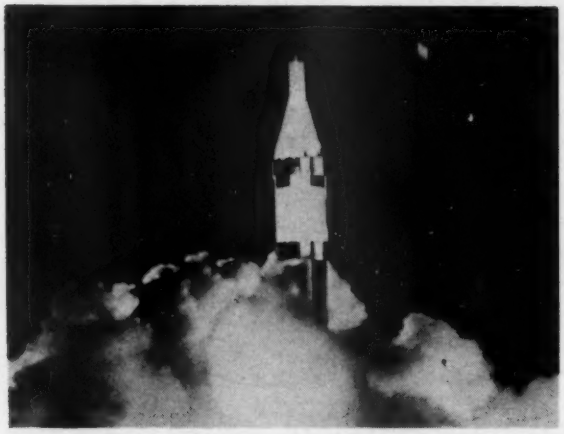
Filament Winding

A great deal of research is being carried out by both raw material companies and missile and rocket manufacturers to seek more effective ways of taking advantage of the properties of fiber glass which make it so adaptable to this program. The most encouraging of these research projects is in the field of filament winding, under development for the past 4 years. Fiber glass filament-wound motor cases and pressure vessels for missiles and rockets have been produced which have gone through severe tests with excellent results. It is believed that in the near future finished products will be produced by filament winding that have a higher strength-to-weight ratio than can be obtained from any other known structural material in existence today.

High modulus of elasticity, light weight, strength, and high-temperature resistance are the most important properties demanded for filament-wound parts, particularly for missile applications. Filament-wound parts

using glass-epoxy systems have been produced with unidirectional tensile strength as high as 230,000 psi at room temperature. In this process, as many as 180 glass fibers one-tenth the diameter of a human hair are spun together, then wound around a mandrel, or pattern, in the desired shape of the case or vessel. The glass is then bonded together with a plastic resin. When the resin cures, the mandrel is removed. These parts can be fabricated cheaper than can sheet metal or aluminum tanks, and are stronger and lighter in weight.

The A-2 Polaris missile, which went hurtling 1400 mi. down the Atlantic Missile Range on a successful test flight, has a second-stage filament-wound motor case which contains 268,000 mi. of glass roving, enough to reach from the earth to the moon. The third-stage Minuteman motor case has 188,604 mi. of fiber glass filament winding. First-stage rocket motor cases for Minuteman and Polaris are now in development which will require approximately 800 lb. of glass fiber per case. Filament-wound structures are lighter, stronger,



Submarine-based Navy Polaris strategic missile.

and less expensive than titanium cases, which in turn are four times lighter than steel cases. On the other hand, filament-wound cases in intermediate stages are not so stiff as titanium cases nor so resistant to buckling. These problems are being dealt with, however, and encouraging results are in evidence.

New And Better Glass

In addition to resins with higher heat resistance, research technologists have been seeking and experimenting with new forms of glass to keep pace with changing requirements of the military. In cooperation with the Navy Bureau of Aeronautics, Airborne Equipment Division, and the U.S. Air Force Materials Center, Owens-Corning Fiberglas has produced new basic glass fibers that will give higher ultimate strength to composite structures. The company has also developed, in conjunction with the Wright Air Development Division, U.S. Air Force, a high-modulus glass (YM31A) which, in a composite structure in a unidirectional pattern, provides a modulus (rigidity) increase of up to 45 per cent over composite structures using standard "E" glass with no loss in strength. An Owens-Corning experimental high-temperature glass is reported to possess tensile strength of 100,000 psi at 1600°F, 20 per cent

Air Force 3-stage solid propellant Minuteman rocket.

better than previously available. Its performance in a composite structure is under investigation.

Aircraft

Run down the list of the fastest and most modern aircraft in flight today—the jets—and you'll find scores of fiber glass applications.* The Boeing 707, Convair 880, Douglas DC-8, and Lockheed Electra, contain fiber glass thermal and electrical insulation to resist temperature extremes and noise, as well as fiber glass reinforced plastic in a number of areas such as lounge seats,

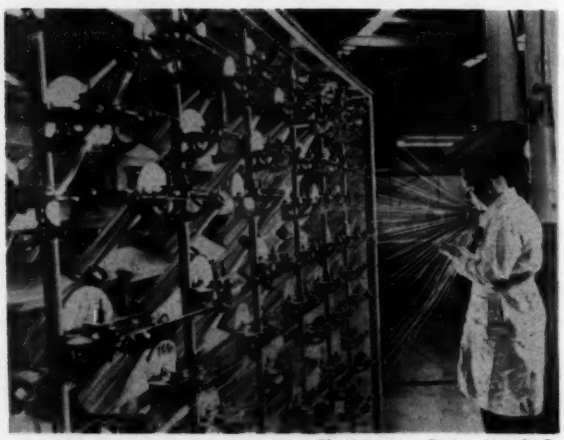


Photo courtesy Boeing Aircraft Co.

Tension rack holds 180 spools of fiber glass thread which are fed into resin-impregnating device and winding machine.

drop ceilings, partitions, nose and tail cones, ducts, antennas, radomes, and "hat section" supports for floors, to mention only a few. The glass used has been in the form of cloth, mats, roving, and chopped strands.

* See The Glass Industry, P. 338, June, 1960.

Because of the outstanding performance of fiber glass thermal, acoustical, and electrical insulation and fiber glass reinforced plastics in both commercial and military aircraft, it is a good bet that these forms of glass will find many applications in the supersonic transports which some experts believe will be a reality by 1970.

Among the most recent applications of FRP in aircraft design are the first such airplane FRP undercarriage constructed in Sweden by Malmo Flygindustri, and the first glider with all FRP fuselage was recently produced by Fiberlite Products Co. of Edmonton, Canada.

The new "Meteor" twin-engine, four-place private plane built by Saturn Aircraft & Engineering Co. has FRP wing tip tanks, nose section, vertical fins, control tips, and engine cowlings.

The latest Bell helicopter has air ducts molded of phenolic-impregnated fiber glass cloth. These ducts, the company says, withstand higher temperatures than thin-gauge metal ducts. Also, tooling costs are lower and the

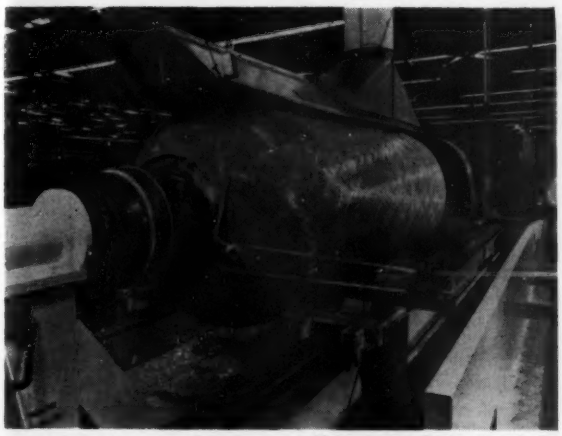


Photo courtesy Boeing Aircraft Co.

Helical filament winding machine forms impregnated threads into single band and winds them around pattern.

fiber glass ducts weigh considerably less than metal.

It is reported that the new Convair 990 jet transport, to be placed in service this year, will have, in addition to many of the aforementioned applications, lounge seats consisting of FRP skins surrounding a thermoplastic resin foam core. Galleys for some of the new commercial jets have been designed with FRP insulating control panel boards .025 in. thick.

Kaman Aircraft of Bloomfield, Conn., is making the first FRP rotor blade for helicopters to be used on its experimental Huskie H-43B designed for U.S. Air Force crash rescue operations. The same company originally made its rotor blade spar sections entirely of wood and later switched to a combination of wood and FRP. The company says the fiber glass blade saves manufacturing and maintenance costs, prevents corrosion and weathering, and provides increased fatigue resistance.

U.S. Army helicopters are now being equipped with break-away fuel tanks molded of FRP. These tanks are strapped to the plane and can be released prior to crashing to avoid fire.

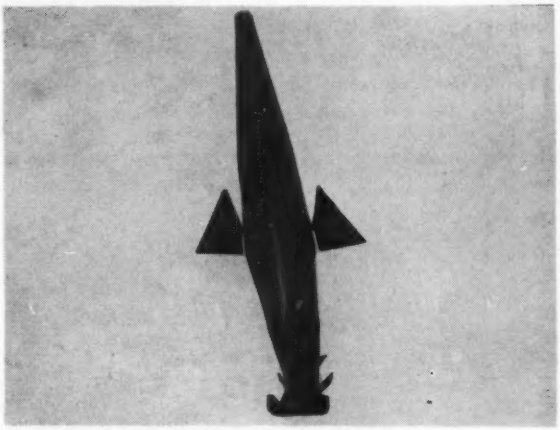
Piper Aircraft's 1961 Cherokee, a 4-passenger private plane, contains FRP wing tips, tail cone, nose cowl, stabilator, rudder tips, and fins. Use of fiber glass plastic enabled the company to make bigger and far fewer pieces in its assembly, and helped to streamline production for cost cutting. Piper has a major research and development program in full swing with an all-FRP plane in mind. A fiber glass plastic fuselage would lower labor costs by eliminating the need for riveting.

Fiber Optics

Fiber optics, utilizing fiber glass, are beginning to find applications in aircraft, too. The Air Force is experimenting with a glass fiber optical surveillance system to enable the pilot of its Dyna-Soar tactical glider to detect leaks, smoke, and other hazards in remote parts of the glider and Titan booster. The device, consisting of a bundle of glass .002 in. in diameter, would enable the pilot to look directly into the various compartments of the glider without leaving his seat.

And so it goes. There are other aircraft applications too numerous to mention here but which, when added to those already spelled out, leave room for only one conclusion: fiber glass is very much in the forefront in aircraft design today.

The most important conclusion to be drawn regarding the use of fiber glass in aircraft, in our opinion, is the adaptation of FRP to fundamental, structural sections of the aircraft itself—those parts of a plane in which a failure would result in the probable loss of the craft. Until a short time ago, no designer would consider using "plastics" in these critical areas. Today, glass fiber



The 60-ft., 3-stage Army Nike Zeus antimissile missile.

laminates have "earned their wings." Designers know both their limitations and their strengths, and can specify them with the assurance that comes only from years of trial and test. The aircraft industry has now had over a decade of such experience.

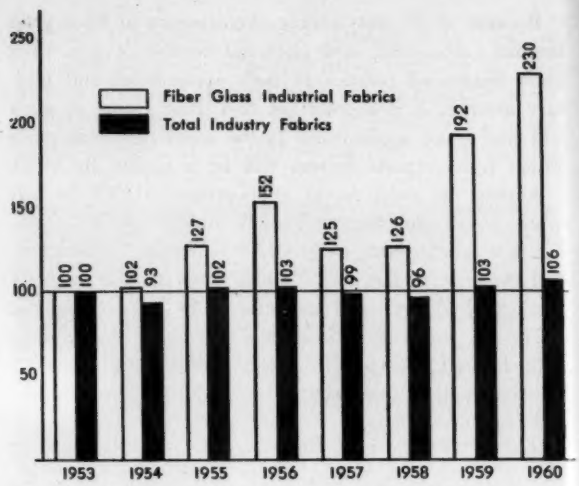


Fig. 1. Index of Average Monthly Sales (1953=100).

Fiber Glass and the Weaver

by Irwin J. Gusman

Manager, Industrial Glass Fabrics Dept., J. P. Stevens & Co., Inc.

Ceramics and textiles are two of the oldest and most fundamental of man's industries. The weaver of fiber glass fabrics has combined these two basic technologies, and in so doing, has opened up new markets and opportunities for both the textile industry and the glass maker. Fiber glass fabrics, because of their unique characteristics, have found a steadily increasing market since their commercial introduction less than 25 years ago, with spectacular growth in the last 5 years (Fig. 1).

Individual glass fibers are durable, incombustible, corrosion resistant, and have excellent thermal and acous-

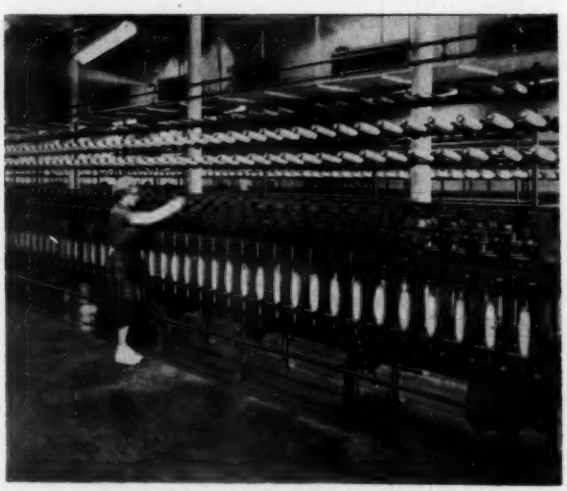


Fig. 2. Twisting and Plying.

Fig. 3. Warping.

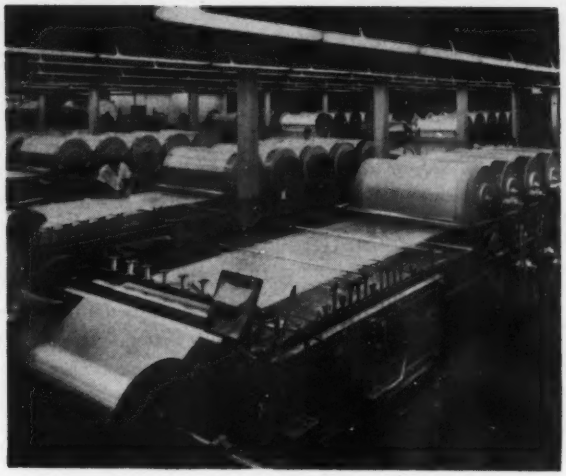


Fig. 5. Slashing

ical properties. Of the many forms in which the glass fiber is used today, woven glass fabric offers the most exacting control over thickness, weight, and strength. Thus, the glass weaver serves as a converter of the basic glass filaments into an infinite variety of engineered materials designed for a multitude of commercial and military products.

As the markets for industrial glass fabrics have grown, the textile industry has had to reorient its thinking, developing technical and marketing competence in fields ranging from glass technology, polymer chemistry, marine design, and electrical engineering to air pollution control and space technology. The rapid growth pattern of the glass fabric industry is the direct result of aggressive research and development and heavy capital investment. The weaver has had to "staff up" with the needed technical service, research people and facilities, product and process development, and quality control, specifically for fiber glass fabrics. In addition to developing new weaveing processes, he has also had to adapt existing manufacturing techniques to meet the particular requirements for handling fiber glass.

FIBER GLASS WEAVING

The weaver has had to apply vast amounts of industrial and equipment engineering to the basic weaving processes (Fig. 2 through 6) in order to produce economically the needed fabrics from the glass yarns.

Twisting and Plying (Fig. 2)

By selecting coarse or fine filaments and by varying the number of filaments, this process serves to control the yarn strength, diameter, and flexibility. The filaments are twisted to a predetermined specification, and the twisted threads are then combined, or plied, to balance and avoid any stress in the yarn which could cause processing difficulties. Some glass fabrics are woven from singles yarns as received from the yarn producers, but by twisting and plying we obtain greater strength, smoothness, and uniformity.

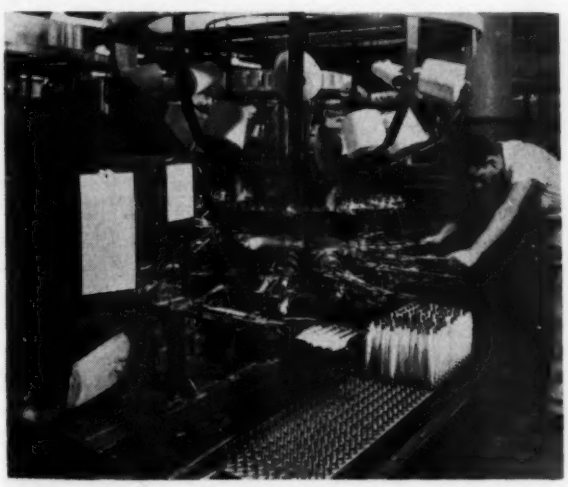


Fig. 4. Quilling.

Fig. 6. Weaving.

Warping (Fig. 3)

The next function in producing woven fabric is accomplished by laying the fiber glass yarns in parallel order preparatory to their introduction to the loom. The yarn is creeled and a specified number of threads per inch are drawn from the creel, all parallel, and wound on a warp beam. If nontwisted yarn is used, warp-sizing is applied to the yarns to facilitate handling and to provide protection during the weaving process. Several warp beams are then combined to provide for the designated number of threads/inch called for in the fabric specification, and the entire system of parallel threads are wound on a loom beam. These become the "warp" or the vertical system of threads in the fabric, and are mounted directly on the loom. In the manufacture of woven roving the yarn is mounted in a creel behind the loom, and the roving is pulled directly from the creel into the loom. This is feasible and economical because of the relatively heavier and thicker nature of the glass roving.

Quilling (Fig. 4)

This is the process of winding the filling yarns onto filling bobbins or quills used in the loom shuttle. The quills locked in the shuttle perform the function of placing yarn at right angles to the warp yarns. The shuttle traverses from one side of the warp to the other, interlacing the two systems of threads "warp" and "filling" on a prearranged weave plan, at bullet-like speeds of 160 to 170 traverses per minute.

Slashing (Fig. 5)

This operation involves *(1)* sizing single-fiber glass warp yarns with a specially compounded chemical formulation, *(2)* drying the yarns, and *(3)* winding the desired number of ends on the loom beam. The sizing is applied to insure the warp yarns against injury from harness wear in the loom.

Entering

In this process the warp ends are threaded from the warp beam through the eyes of the correct heddles on the respective harnesses to achieve the desired pattern or design in the fabric.

Weaving (Fig. 6)

This operation consists of interlacing a series of fiber glass filling yarns with a series of warp yarns at right angles. To weave fiber glass fabrics successfully, a number of loom innovations must be used.

SELECTION OF FIBER GLASS FABRIC

Because fiber glass fabrics and tapes are highly engineered, many factors must be considered when selecting the proper fabric design for a particular application. Weight, thickness, and strength requirements must be known. For special end uses such as dry filtration, flexibility and permeability factors are needed, and naturally, cost must always be kept in mind. For the electrical industry, finer gauges and high dielectric requirements are important.

BASIC WEAVES

The basic weaves—plain, twill, and satin—are available in fiber glass fabrics. Many variations of these, including crowfoot satin, leno, 8-harness satin, mock leno, unidirectional and high modulus weaves are also produced. Some of the basic weaves available in glass fabrics are illustrated in Fig. 7.

The plain weave, in which yarns are interlaced in an alternating fashion over and under every other yarn, is used for all electrical insulating fabrics, as well as for most fabrics in the plastic coating industry. The plain weave affords the maximum where fabric stability and firmness is required. Minimum yarn slippage is also a feature of this weave. The satin weaves are used to best advantage in the reinforced plastic field, especially for prepregs for the aircraft and missile field. High Modulus is a patented weave produced by J. P. Stevens & Co., Inc., and is used where high laminate values are needed. Improved tensile and flexural properties, as well as impact strength, result from reduction of crimp and shear factors by eliminating interlacing of the structural yarns. The high modulus fabric is held together by very fine binder threads. The crowfoot satin weave, in which warp yarns interlace with fill yarns in a three over one under pattern, is used where softer fabric and greater drape is required. Fabrics with crowfoot weaves conform more easily to highly contoured surfaces.

The 8-harness satin weave is more pliable than the crowfoot and conforms readily to intricately contoured planes. Satin weaves, both crowfoot and 8-harness, can be woven with more threads per inch or with greater density. The leno weave is used to maintain uniformity of threads and minimize distortion where a relatively low number of threads per inch are required. Glass fabrics using leno weave to good advantage are applied for reinforcing grinding wheels and for light-weight membrane fabric base for protective coatings.

Glass fabric constructions are generally selected on the basis of several combinations of strength, weight, and thickness. For reinforcing rigid plastics, weave pattern materially affects ultimate laminate values. Weaves with longer "floats" or less interlacing generally supply higher properties to laminates. Longer "float" weaves are the 8-harness satin, crowfoot satin, and high modulus. These are most widely used in the aircraft and missile field where flexural, tension, and compression requirements are critical. The satin weaves require more threads per inch to retain stability, and these constructions are generally produced in the medium and heavy weight range. The thinnest and lightest weight cloths are achieved by use of the plain weave. Fabrics as fine as 1 mil in thickness are produced for the electrical industry for mica backing. Here, the relatively high strength of glass fabric and extremely fine gauge make it an ideal material.

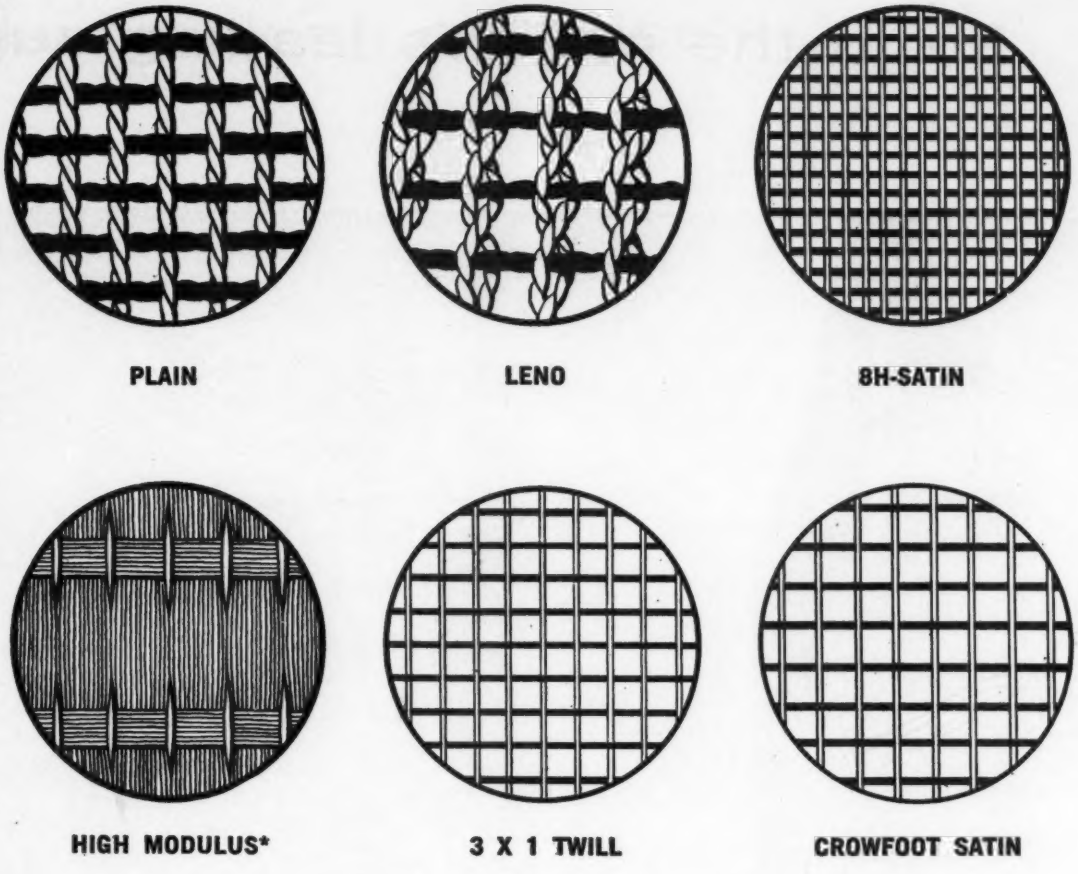


Fig. 7. Basic Weaves (*Patented J. P. Stevens Weave).

STRENGTH

The strength of the fabric is directly proportional to the number of yarns per inch and the strength of the yarn selected. Unidirectional fabrics with many times more strength in the vertical or warp direction are produced by weaving the maximum number of yarns in the warp direction and a minimum number of filling yarns. These yarns can be less expensive since it is more costly to interlace "fill" yarns than it is to interlace "warp" yarns. The unidirectional fabrics are widely used in fiber glass fishing rods and as reinforcement for pressure-sensitive tapes. A wide range of glass fabrics is available from 1 oz. per sq. yd. to over 40 oz. per sq. yd. Tables I and II list the various industrial fabric constructions generally used for the electrical, coating, plastic reinforcement and filtration fields (see page 328).

FABRIC FINISHING

As glass fibers are manufactured, a binder is applied to the filaments to maintain strand integrity and to protect the fibers from physical breakage during subsequent processing and weaving. In some cases (many electrical applications), the binder is left on the yarns and has no adverse effect on the final product.

In glass reinforced plastic laminates, however, it is necessary to remove the binder and warp sizing and replace it with a finish or chemical compound that will act as a coupling link between the glass interface and the resin. If this is not done, utmost compatibility will not be achieved and maximum properties of the laminates will not be realized.

It is necessary to select the correct finish for use with each different resin system. Recommended finishes for the various resins are given in Table III.

TABLE III

Resin System	Recommended Finish
Polyester	Volan A, Garan, A-172
Epoxy	Volan A, A-1100, 516
Melamine	516, 111
Phenolic	A-1100, 516
Silicone	112, Neutral pH, 136

The Volan A finish, which is most widely used, is obtained by saturating heat cleaned fabric with methacrylate chromic chloride, curing the chrome compound, and washing the fabric thoroughly to remove any remaining soluble salts. The Garan and A-172 finishes are basically vinyl silane coupling agents, and the A-1100 finish is a reactive amino silane. (*Continued on page* 328)

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TABLE I

Fiber Glass Fabric Uses	Recommended Fabrics*
ELECTRICAL	
Varnished Sheets and Tapes	104, 107, 108, 112, 113, 116, 127, 1165, 1456
Teflon Coated Sheets and Tapes	108, 116
Silicone Rubber Coated Sheets and Tapes	104, 116, 127, 1564
High-Pressure Laminates	112, 116, 1528, 1539, 1564, 7528
Backing for Mica Tapes	104, 107, 108, 325
Rubberized Sheets and Tapes	1510, 1526, 1528, 1562
COATED FABRICS	
Aircraft Interiors	119, 120, 1510, 1520, 1526, 1528
Awnings and Canopies	119, 1185, 1510, 1526
Pressure-Sensitive Tape	116, 1165, 1660, 1667
Air Ducts (Flexible)	112, 164, 1125, 1526, 1528
Gaskets	190, 191, 1528
Roofing Membrane and Protective Coatings	174, 191, 1620, 1658, 1610
Acoustical Tile	354, 1610, 1620

Fiber Glass Fabric Uses	Recommended Fabrics*
PLASTIC REINFORCEMENT	
Aircraft and Missiles (Structural)	112, 116, 120, 128, 143, 162, 164, 181, 183, 184, 1581, 1582, 1584
Tooling	1587, 1597, 7500, 7520, 7532, 7533, 7544
Boats	7500, 7520, 7532, 7533, 7544, 173, 175
Fishing Rods	143, 1543, 1557
Automotive	7500, 7520, 7532, 7533, 7544
Tanks and Pipes	181, 1528, 1581, 1543, 7585
Military Custom Molding	According to Specifications
Geodesic Radomes	7585
Grinding Wheels	1505, 1589, 1590
FILTRATION	
Dust	401, 402, 1722, 1724
Aluminum	199, 306, 307, 1587

* See Table II for description of recommended fabric specification numbers.

TABLE II

Dust Filtration Glass Fabrics

Style	Permeability Range SLKN† Treated	Mullen Burst Strength SLKN† Treated	Oz./Sq. Yd.	Thickness	COUNT	TENSILE SLKN† TREATED		YARN		Weave
					Warp X Fill	Warp	Fill	Warp	Fill	
401	15-20	500	9.36	.0097	54 X 52	190	180	150-1/2	150-1/2	Cr. Satin
402	10-14	500	9.50	.010	54 X 54	190	190	150-1/2	150-1/2	Cr. Satin
1722	45-60	400	16.30	.0172	48 X 22	250	125	150-2/2	31/2 Staple	2 X 2 Reverse Twill
1724	30-40	450	17.67	.020	48 X 24	250	130	150-2/2	31/2 Staple	2 X 2 Reverse Twill

Aluminum Filtration Glass Fabrics

Style	Openings Per Sq. In.	Oz./Sq. Yd.	THREAD COUNT		TENSILE STRENGTH		YARN		Weave
			Warp	Fill	Warp	Fill	Warp	Fill	
199	154	12.44	42	32	520	430	150-2/2	150-2/2	Mock Leno
306	96	11.00	40	24	375	200	150-2/2	150-2/2	Mock Leno
307	64	7.85	24	24	225	200	150-2/2	150-2/2	Mock Leno
1587	70	20.06	40	21	950	530	150-4/2	150-4/2	Mock Leno

†Trade Mark J. P. Stevens & Co., Inc.

TABLE II *(Continued)*

Woven Roving

Style	Oz./Sq. Yd.	Thickness in In.	CONSTRUCTION		TENSILE STRENGTH		Weave
			Warp	Fill	Warp	Fill	
173	18.00	.035	7 ends of 30 end roving	6 picks of 2 x 15 end roving	700	600	Plain
175	24.50	.042	5 ends of 60 end roving	4 picks of 2 x 30 end roving	1,400	1,000	Plain
210	27.00	.048	4 ends of 80 end SPUN roving	3 picks of 2 x 40 end SPUN roving	400	350	Plain

Industrial Glass Fabrics

Style	Oz./Sq. Yd.	Thickness in In.	THREAD COUNT		TENSILE STRENGTH		YARN		Weave
			Warp	Fill	Warp	Fill	Warp	Fill	
127	6.10	.007	42 X 32		225	185	450-3/2	450-3/2	Plain
128	6.00	.007	42 X 32		250	200	225-1/3	225-1/3	Plain
143	8.78	.009	49 X 30		611	56	225-3/2	450-1/2	Cr. Satin
162	12.20	.0150	28 X 16		450	350	225-2/5	225-2/5	Plain
164	12.72	.016	20 X 18		500	450	225-4/3	225-4/3	Plain
181	8.90	.0085	57 X 54		340	330	225-1/3	225-1/3	8H Satin
183	16.75	.018	54 X 48		650	620	225-3/2	225-3/2	8H Satin
184	25.90	.027	42 X 36		950	800	225-4/3	225-4/3	8H Satin
190	2.53	.006	20 X 10		92	58	225-1/3	225-1/3	Leno
191	1.65	.005	20 X 10		62	40	225-1/2	225-1/2	Leno
1505	9.94	.0175	10 X 10		494	480	150-3/4	150-3/4	Plain
1510	4.88	.0056	32 X 29		220	210	150-1/2	150-1/2	Plain
1526	5.50	.006	34 X 32		225	195	150-1/2	150-1/2	Plain
1528	6.00	.007	42 X 32		250	200	150-1/2	150-1/2	Plain
1539	5.60	.0065	39 X 28		250	180	150-1/2	150-1/2	Plain
1543	9.40	.009	49 X 30		660	70	150-2/2	450-1/2	Cr. Satin
1557	5.42	.0055	57 X 30		370	60	150-1/2	450-1/2	Cr. Satin
1564	13.00	.015	20 X 18		500	450	150-4/2	150-4/2	Plain
1581	9.00	.0085	56 X 54		350	325	150-1/2	150-1/2	8H Satin
1582	13.45	.0134	60 X 56		440	400	150-1/3	150-1/3	8H Satin
1584	24.54	.0246	44 X 35		950	800	150-4/2	150-4/2	8H Satin
1589	12.00	.019	13 X 12		550	470	150-3/4	150-3/4	Plain
1590	10.04	.020	10 X 5		330	370	150-4/3	150-4/5	Leno
1660	2.78	.005	60 X 12		230	48	150-1/0	150-1/0	Plain
1667	2.50	.003	60 X 12		225	5	150-1/0	900-1/0	Plain
7528	5.80	.007	42 X 32		200	160	75-1/0	75-1/0	Plain
7585	26.00	.024	64 X 20		1500	415	75-2/2	75-1/3	8H Satin

TABLE II *(Continued)*

Glass Scrim Fabrics

Style	Oz./Sq.	Thick-ness	THREAD COUNT Warp	Fill	TENSILE Warp	Fill	YARN Warp	Fill	Weave
174	1.60	.006	26	12	89	65	150-1/0	150-1/0	Leno
1620	1.60	.004	20	20	80	60	150-1/0	150-1/0	Plain
1658	1.65	.004	20	10	80	70	150-1/0	75-1/0	Plain

Glass Boat and Tooling Fabrics

Style	Oz./Sq. Yd.	Thick-ness in In.	THREAD COUNT Warp	Fill	TENSILE STRENGTH Warp	Fill	YARN Warp	Fill	Weave
1520	8.71	.012	18	18	370	370	150-3/2	150-3/2	Plain
1587	20.06	.030	40	21	950	530	150-4/2	150-4/2	Mock Leno
1597	40.00	.045	30	30	1300	1300	150-4/4	150-4/4	12H Satin
7500 formerly (1500X)	9.70	.014	16	14	450	410	75-2/2	75-2/2	Plain
7520 formerly (1520X)	8.71	.012	18	18	370	370	75-1/3	75-1/3	Plain
7532 formerly (1532X)	7.50	0.10	16	14	335	316	75-1/3	75-1/3	Plain
7533 formerly (1533X)	6.00	.009	18	18	250	220	75-1/2	75-1/2	Plain
7544 formerly (1544X)	19.20	.022	28	14	745	830	75-2/2	75-4/2	Plain

Lightweight and Electrical Glass Fabrics

Style	Oz./Sq. Yd.	Thick-ness in In.	THREAD COUNT Warp	Fill	TENSILE STRENGTH Warp	Fill	YARN Warp	Fill	Weave
104	.58	.001	60	52	40	15	900-1/0	1800-1/0	Plain
107	1.06	.0017	60	35	70	20	900-1/2	900-1/0	Plain
108	1.44	.002	60	47	70	40	900-1/2	900-1/2	Plain
112	2.12	.003	40	39	82	80	450-1/2	450-1/2	Plain
113	2.47	.003	60	64	123	60	450-1/2	900-1/2	Plain
116	3.16	.004	60	58	125	120	450-1/2	450-1/2	Plain
119	2.80	.004	54	50	110	100	450-1/2	450-1/2	Plain
120	3.16	.004	60	58	125	120	450-1/2	450-1/2	Cr. Satin
325	.70	.0012	90	44	65	15	900-1/0	1800-1/0	Plain
354	2.0	.0075	20	8	60	50	150-1/0	40-1/0 Staple	Plain
1125	2.60	.0035	40	39	90	130	450-1/2	150-1/0	Plain
1165	3.65	.0043	60	52	150	135	450-1/2	150-1/0	Plain
1185	4.13	.0055	90	46	250	210	450-1/2	150-1/0	Cr. Satin
1456	1.90	.004	32	28	40	100	Dacron	150-1/0	Plain
1562	1.94	.005	32	16	75	60	150-1/0	150-1/0	Leno
1610	2.48	.004	32	28	115	100	150-1/0	150-1/0	Plain

PAST GROWTH AND CURRENT APPLICATION OF WOVEN GLASS FABRICS

Since 1955 the glass weaving industry has increased its consumption of glass fibers for industrial fabrics by 200 per cent. This spectacular growth was derived from several areas, but more than any other, from fiber glass reinforced plastics. By combining the actual 400,000 lb. per sq. in. tensile strength of fiber glass with the elasticity and adhesion of a wide variety of resins, it became possible to obtain structural materials with fascinating composite properties: (*1*) corrosion resistance, (*2*) ease of forming shapes difficult or costly to produce in metal, (*3*) good heat, electrical, and sound insulation characteristics, (*4*) high impact strength, (*5*) impregnated color, (*6*) low payload costs, and (*7*) high strength-weight ratios.

These versatile materials are the foundation of the reinforced plastics industry which has grown from an annual consumption of 3,000,000 lb. of fiber glass and plastic in 1942 to 260,000,000 lb. in 1960, and which, it is conservatively estimated, will be more than half a billion pounds (resin and all types of fiber glass) by 1965. Fiber glass fabrics have shared in this amazing growth.

Boats

Fiber glass reinforced plastics represented a major breakthrough in the marine field in the constant battle against surface deterioration. Introduced in 1953, fiber glass boats attained about 15 per cent of the market by 1956, increased its share to 36 per cent during 1960, and is expected to rise to 60 per cent by 1965. In production, woven reinforcement, such as cloth or woven roving, is combined with glass mat or chopped fibers. Spun woven roving, recently introduced, combines the advantages of mat and woven roving and is expected to find wide acceptance. Although the majority of today's fiber glass reinforced plastic hulls are in the 14- to 19-ft. class, fiber glass is finding increasing acceptance for work boats, yachts, and military craft up to 60 ft. in length. The U. S. Navy and Coast Guard have more than 700 fiber glass boats in use, ranging from 9-ft. dinghies to an 80-ft. training ship.

Increased usage of nonwoven glass mats as the basic reinforcement, and more significantly, a substantial rise in the use of the "spray-gun" technique have somewhat decreased the use of glass textiles in the marine field during the past two years. The "spray-gun" technique chops glass filaments, mixes them with resin and blows the mix on the mold, all in one application. However, most builders have now altered this process, incorporating layers of woven roving and glass cloth into the lay-up to achieve a standard of uniformity and strength which cannot be attained by the exclusive use of the "spray-up" technique.

Aircraft and Missiles

Use of glass textiles for aircraft and missiles increased by 100 per cent last year. In these fields the rigid and exacting requirements for light weight, durability, and utmost uniformity dictate the use of glass fabric reinforcement. Because of security regulations or use as unseen or unidentified components of missiles or aircraft, the public and much of general industry are not aware of the high strengths and exacting performances turned in by glass fabric reinforced plastics. For instance, the ablative properties of fiber glass fabric reinforced plastics have permitted recovery of missile nose cones fired over a 5500-mi. range where the re-entry vehicle retained structural integrity at temperatures as high as 13,000°F while hurtling through the earth's atmosphere at speeds up to 15,000 mph. Glass fabrics used for this field are leached to an almost pure (99 per cent) silica cloth by H. I. Thompson Fiber Glass Co., Los Angeles, Calif., and Haveg Industries, Wilmington, Del. Leached glass fabric, produced by these companies, was the base reinforcement for the nose cone and exhaust nozzles of the Minuteman missile, which had a recent successful firing. Many other missile systems use leached glass fabrics because of the excellent ablative and high-temperature qualities of this material.

Miscellaneous Uses of Fiber Glass Reinforced Plastics

Fiber glass reinforced plastics made with glass textiles find application in everything from fishing rods to swimming pools. Lancer Industries has pioneered in the development of fiber glass reinforced plastics pools using woven roving in conjunction with random oriented glass mat. Large corrosion-resistant tanks are produced in a similar fashion. The extremely high tensile strength and uniformity of woven roving, coupled with its economical price, makes this product ideal for building large fiber glass reinforced plastic structures.

Hollow fishing rods, as well as golf clubs using unidirectional glass fabrics, make a premium quality item. Glass fabrics used as the base reinforcement for grinding wheels supply the necessary strength to prevent disintegration of the disk at high speeds and withstand the high temperatures generated by high-speed abrasive action. For the military, glass textiles have been used for many years to produce bullet-proof vests.

Housings for radar installations of commercial and military aircraft are made of polyester or epoxy laminates reinforced with glass fabrics because they are transparent to high-frequency radiations. Here strength and uniformity are of paramount importance. A spherical radome of 6-sided fiber glass reinforced plastic panels bolted together rise to the height of a 15-story office building. These radomes form the basis of the Air Force's Ballistic Missile Early Warning System. The system is designed to detect enemy ballistic missiles immediately after launching, track them in their flight, and predict their impact points. The 176-ft. high structure, 142 ft. in diameter, was built by Goodyear Aircraft Corp. for R.C.A., the weapon systems contractor responsible for construction of the warning system under contract to the U.S. Air Force.

Coated Glass Fabrics

Besides achieving widespread use in the electrical industry as a base for high-pressure laminates for printed circuits, glass fabrics have proven to be a superior material for insulating sheets and tapes. Used in conjunction with oleoresinous varnishes, Teflon, and silicone rubber, glass textiles are an ideal base because of their extremely high dielectric strength, excellent resistivity, low dielectric loss, and maximum stability under practically all atmospheric conditions. They have been widely used for heating blankets, hot air ducting, flexible bellows, and gaskets and coils for rotating machinery. For the coating industry, glass fabrics offer thermal and dimensional stability as well as high strength. Besides electrical insulation, some of the industrial applications for coated glass fabrics are for aircraft engine baffle seals, gaskets, honeycomb press blankets, dielectric heat sealing blankets, heat ducting, and industrial curtains. Unidirectional glass fabric is presently being widely used as the reinforcement for paper and film sealing tapes.

Flexible ducts made of coated glass cloth are revolutionizing the handling of air, liquids, and light solids. These ducts withstand wide temperature and pressure ranges, remove fumes, gases, and odors, collect dust, lint, and soot, and can convey light solids, gases, and liquids. Flexible Tubing Corp. of Guilford, Conn., has pioneered in this development. Special flexible tubing is used in aircraft for ducts to carry air for heating and cooling, cabin pressurization, deicing and defrosting, fuel handling, and ventilation of parts and systems. The glass fabric base withstands supersonic speeds, vibration, and wide temperature extremes.

Filtration

Air pollution by smog and smoke is a serious problem for more than 10,000 American communities from the standpoint of health, property damage, morale, and industrial operating costs. Bethlehem Steel, to overcome the problem of electric furnace fume dust, installed 792 fiber glass bags, each 11½ in. in diameter and 25 ft. long. The specially treated glass bags have operated successfully because of their ability to withstand high temperatures and their superior chemical resistance. In addition, they have eliminated the need for costly equipment to cool and collect the effluent. Fiber glass will not shrink or stretch like other fabrics, and therefore, retains a uniform permeability as long as the bags remain in use. The efficiency and low cost of fiber glass relative to other filtering media should increase the market for these bags.

Fiber Glass Insect Screening

One of the most significant developments in the fiber glass story has been the increasingly widespread use of fiber glass insect screening. Here, the dimensional stability and high tensile strength of glass yarns are used to best advantage by coating them with corrosion- and weather-resistant vinyl compounds. These yarns are then woven into the standard screening mesh, and by application of the proper amount of heat, are "set," thereby eliminating any possible distortion. The woven yarns are held in position under slight tension and heated to over 350°F. This is the vitally important bonding operation which fuses the yarns together where they cross each other, a unique advantage of fiber glass insect sreening. Fiber glass insect screening is rust proof, cannot stain, and is resistant to salt air and other common corrosive atmospheres. Because of the fiber glass reinforcement, a cigarette cannot burn a hole in it and the material cannot shrink. The locked or "set" weave prevents shifting or ravelling. While the usage of fiber glass insect screening has remained static during the past several years, there are signs that because of its properties, but more important, because of its increasingly competitive position, that volume will increase significantly. Fiber glass insect screening was previously slightly higher in cost than aluminum, but it is now priced below aluminum.

THE FUTURE OF FIBER GLASS TEXTILES

The reinforced plastics field probably offers the most significant potential for glass textiles. The trend for use of a glass fabric is increasing in prepreg form. Prepregs are ready-to-mold combinations of resin and glass fabric, and offer all the advantages of reinforced plastics while maintaining the most consistent and reproducible quality, and saving the labor processing and costs involved in pre-engineering by materials experts. Thus, by the use of prepregs, the plastics engineer can now not only design the requirements of the base glass fabric, but specify the type of resin, molding cycle, etc., that is required for the ultimate product that he intends to fabricate. This assures uniform quality, superior properties, simplified production methods, and greater design freedom. Prepregs are easily adaptable to various types of fabrication techniques, including vacuum bag molding, pressure bag molding, and match metal die molding. Substantial quantities of prepreg glass fabrics are used for fishing rods and honeycomb and grinding wheel inserts, although the largest application is in the missile and aircraft industry.

The electrical industry offers another great potential for the use of glass fabrics because of the constant demand for greater strength and higher temperature resistance for new and future products.

Each milestone in the progress of science presents new problems and new opportunities. The future of fiber glass fabrics is in the laboratories of the glass fiber weavers and yarn producers, and in the aggressive but objective development of new markets where material requirements are critical. Fiber glass fabrics, with their close control on weight, thickness, and strength tolerances as coupled with the unique properties of glass itself, do indeed have a bright future.

The Industry at a Glance...

OWENS CORNING FIBERGLAS CORP.

⊕ AIKEN, S. C. C. R. MacPherson, plant manager. *Fiber Glass:* continuous yarns and rovings. *Markets:* decorative and industrial fabrics; electrical insulation and plastics reinforcement.

⊕ ANDERSON, S. C. W. C. Schenk, plant manager. *Fiber Glass:* continuous roving, chopped strand mat, continuous yarn, vinyl-coated yarns, chopped continuous strands, beamed continuous yarn, and fiber glass flake. *Markets:* decorative and industrial fabrics; electrical insulation; paper, tape, and plastics reinforcement; screening.

⊕ ASHTON, R. I. D. B. Seaton, plant manager. *Fiber Glass:* spun strand roving, staple products, chopped spun strand, continuous yarns and cordage, mop yarns, hammermilled continuous fibers, waxed bonded strand, waxed yarn, and high strand integrity (HSI) chopped strand. *Markets:* decorative and industrial fabrics; electrical insulation; paper, tape, and plastics reinforcement; roofing.

⊕ BARRINGTON, N. J. R. J. Paolitti, plant manager. *Fiber Glass:* batts and rolls, blowing and pouring wool. *Markets:* residential and industrial building; appliances; pipe and duct insulation.

⊕ BERLIN, N. J. O. W. Pfeifer, plant manager. Calcium silicate high-temperature insulation produced. *Markets:* indoor and outdoor heating equipment.

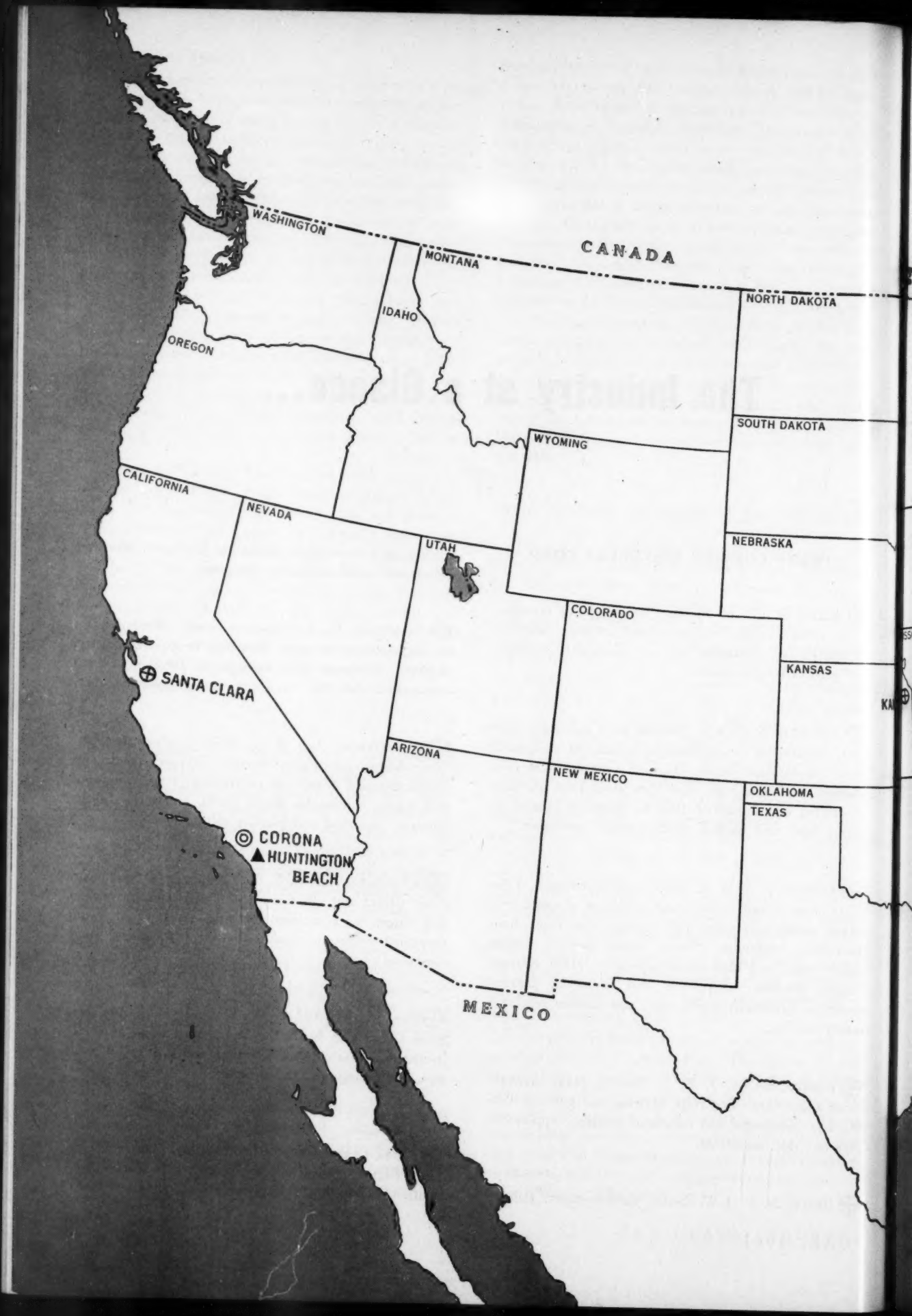
⊕ GRANVILLE, O., TECHNICAL CENTER. Frederick W. Swank, business manager. Research in glass chemistry, physics, mechanics, and metallurgy. Development, in cooperation with the Air Force, of high-modulus fiber.

⊕ HUNTINGDON, PA. R. J. McEvoy, plant manager. *Fiber Glass:* continuous roving, chopped continuous strand, chopped strand mat, continuous yarns, continuous died yarns, continuous waxed yarns, and scrim fabric. *Markets:* electrical and plastics reinforcement.

⊕ KANSAS CITY, KAN. F. R. Coumbe, plant manager. *Fiber Glass:* mat. *Markets:* automotive and transportation industries; equipment and appliances; thermal and acoustical insulation; roofing, battery mat, underground pipe wrap.

⊕ NEWARK, O. Richard L. Stafford, plant manager. *Fiber Glass:* mat, bonded and unbonded wool. *Markets:* insulation, noise control, filtration, and roofing; decorative, reinforcing, and battery mat.

⊕ SANTA CLARA, CALIF. G. M. Falling, plant manager. *Fiber Glass:* bonded and unbonded wool. *Markets:* insulation, noise control, filtration, and roofing.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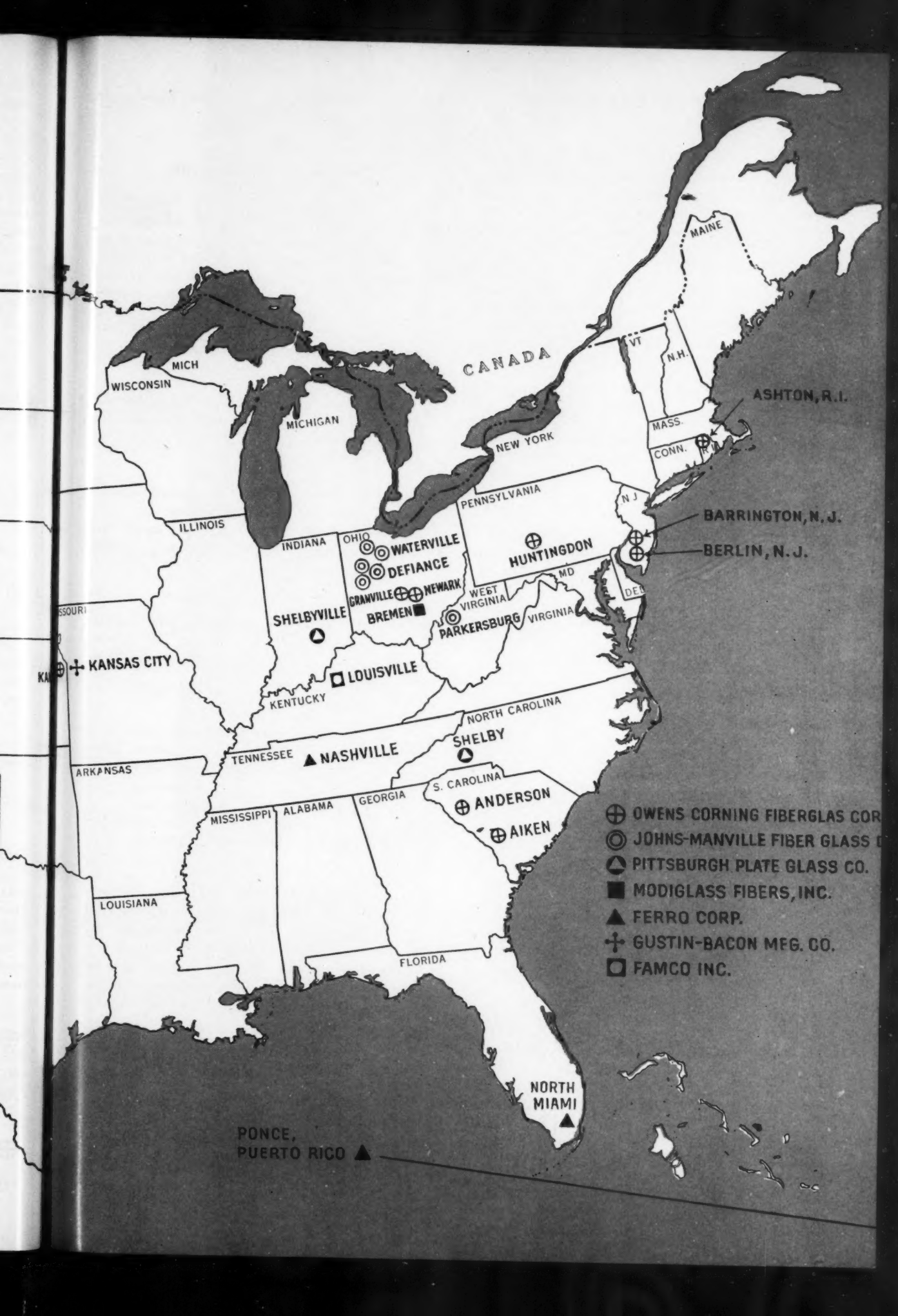
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ANDERSON
AIKEN
MISSISSIPPI
ALABAMA
GEORGIA
LOUISIANA
FLORIDA
NORTH MIAMI
PONCE, PUERTO RICO
OWENS CORNING FIBERGLAS COR
JOHNS-MANVILLE FIBER GLASS
PITTSBURGH PLATE GLASS CO.
MODIGLASS FIBERS, INC.
FERRO CORP.
GUSTIN-BACON MFG. CO.
FAMCO INC.

JOHNS-MANVILLE FIBER GLASS DIV.

◎ CORONA, CALIF. William G. Landry, plant manager. Thermal and acoustical insulation produced. *Markets:* commerical and military aircraft; rockets and missiles; industrial, commercial, and residential insulation; heating and air conditioning equipment; ducts and piping.

◎ DEFIANCE, O. (CARPENTER RD.) Robert W. Dobson, plant manager. Blanket and molded thermal, acoustical insulation produced. *Markets:* insulation for appliances, mobile homes, automobiles, refrigerated truck-trailers and railroad cars.

◎ DEFIANCE, O. (COLUMBUS AVE.) Robert L. Hull, plant manager. Pipe insulation produced. *Markets:* residential, commercial, and industrial construction.

◎ DEFIANCE, O. (THIRD & PERRY STS.) Bernard L. Schoolcraft, plant manager. Thermal and acoustical insulation produced. *Markets:* residential, and commercial, automotive transportation, and marine insulation.

◎ PARKERSBURG, WEST VA. Robert E. Warrick, plant manager. *Fiber Glass:* textile yarns and roving. *Markets:* thermal and acoustical insulation; paper, tape, and plastics reinforcement; appliances; transportation equipment; automobiles, boats, and aircraft; structural panels; industrial fabrics.

◎ WATERVILLE, O. Gerald L. White, plant manager. *Fiber Glass:* textile yarns, roving, chopped strand mat, and bonded mat. *Markets:* electrical; boating and aircraft, industrial fabric; paper, tape, and plastics reinforcement; marina pontoons, roofing, and underground pipe wrap.

◎ WATERVILLE, O., RESEARCH CENTER Dominick Labino, vice-president for research and development. *Fiber Glass:* microquartz and microfibers. *Markets:* thermal and acoustical insulation.

PITTSBURGH PLATE GLASS CO.

◬ SHELBYVILLE, IND. (WORKS 50). J. A. McMillan, plant manager. *Fiber Glass:* roving and mat. *Markets:* building and pipe insulation; duct liners; air filters; insect screening and textile yarns.

◬ SHELBY, N. C. (WORKS 52). *Fiber Glass:* roving. *Market:* textile yarns.

MODIGLAS FIBERS, INC.

■ BREMEN, O. L. J. Melillo, plant manager. *Fiber Glass:* textile-type glass fibers, continuous fiber mat, unidirectional mat, chopped strand, and veil. *Markets:* reinforced plastics; heating, ventilating, and air conditioning filters; air filters; industrial specialty products.

FERRO CORP. FIBER GLASS DIV.

▲ HUNTINGTON BEACH, CALIF. R. C. Riggs, plant manager. *Fiber Glass:* chopped strand reinforcing mat. *Market:* plastics reinforcement.

▲ NASHVILLE, TENN. W. G. Cole, general manager. *Fiber Glass:* chopped strand reinforcement mat, roving, woven roving, milled fibers, and chopped strand. *Markets:* plastics reinforcement; industrial fabrics for boats and tooling; milled fiber.

▲ NORTH MIAMI, FLA. J. G. Browne, plant manager. *Fiber Glass:* chopped strand reinforcing mat. *Market:* colored gel coats and fiber glass reinforcements for the plastics industry.

▲ PONCE, PUERTO RICO (FERRO CARIBE, INC.) H. E. Pitts, plant manager. Tapes and other narrow fabrics produced. *Markets:* boating, tooling, and electrical reinforcements.

GUSTIN-BACON MFG. CO.

✢ KANSAS CITY, MO. (FAIRFAX INDUSTRIAL DISTRICT) J. N. Sawyer, vice-president, operations, and I. D. Snyder, works manager. *Fiber Glass:* reinforcing roving, woven roving, and chopped strand mat. *Markets:* thermal and acoustical insulation; industrial, light, and mobile home construction; commercial and residential heating and air conditioning; automotive and transportation industries.

FAMCO, INC.

◻ LOUISVILLE, KY. E. W. Currier, plant manager. *Fiber Glass:* Mat. *Markets:* plastics reinforcement; filtration; building and roofing products; lamp shades.

Reinforced plastics are winning greater recognition in all branches of the automotive industry as improved materials and cost factors spur advances.

Fiber Glass is Rolling

by Robert S. Morrison

President, Molded Fiber Glass Body Co., Ashtabula, O.

A feature of four U. S. Internatonal Trade Fairs this year is a ground effects machine with a molded fiber glass body. Chevrolet, for the body of its newly introduced experimental Corvette, the Stingray, uses fiber glass reinforced plastic with aluminum framing molded in. In the case of both these "cars of the future," there is a background to the specification of fiber glass reinforced plastic as body material.

The Fiber Glass Car

For the wheel-less Aeromobile, its developer, Dr. William R. Bertelsen, switched to molded fiber glass from the aluminum used in the original model because of greater resistance to the effects of vibration and consequent longer life, greater resistance to impact and easier repair when damaged, and superior moldability which acts to reduce the number of body components and produce more graceful lines.

Photo courtesy Commerce Dept.

Wheel-less Aeromobile is molded in one piece of FRP by the MFG Body Co.

Back in 1953, Chevrolet found that fiber glass reinforced plastic not only was a quick means of producing a dream car for exhibition but was cheaper than steel for 15,000 cars. Though the material actually is more expensive than steel, company engineers calculated that production molds cost only a fifth as much as metal stamping dies. Today, cost of fiber glass reinforced plastics parts has gone down while steel parts have gone up in price, so that the level to which fiber glass for car bodies has a cost advantage over steel is from 25,000 to 40,000 units.

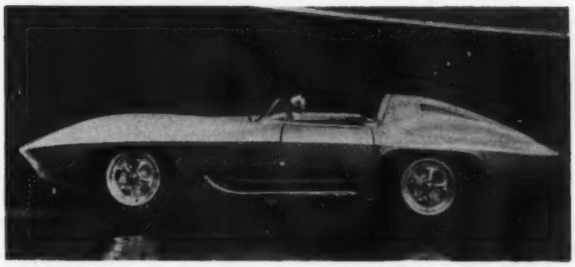


Photo courtesy Chevrolet.

Experimental Corvette, the Stingray, features a FRP body and bonded-in aluminum frame.

The low mold costs made engineering changes in the early Corvettes less expensive and more rapid. On the one hand they made it feasible for the company to continue production at a rate substantially below the 10,000 projection for the first year while the car was reengineered to give each customer what he wanted—manual or automatic transmission, convenient side windows and top, more power. Secondly, the low mold costs made restyling possible without the high expense associated with model changes in steel bodies.

Chevrolet's experience with the Corvette has special significance today as a possible solution to the economic problem of low-volume models to satisfy ever more segmented markets. Last year, several luxury cars would have been more profitable with fiber glass plastic bodies. Using molded fiber glass, an American manufacturer might well follow the example of Volkswagen with the Karmann Ghia and offer an alternate body style, possibly dubbed a "fiber glass custom model," at a higher price. Besides the obvious selling advantage of an alternative body style, such a reinforced plastic car would appeal to that growing segment of the public interested

in a car with long-time, trouble-free good looks and performance.

A prerequisite, though, is public awareness of the advantage of fiber glass reinforced plastics' corrosion and impact resistance in car bodies on a par with that of the truck manufacturer and operator. Only recently—

Photo courtesy Celanese Corp. of America.

FRP is molded around a steel liner in Heil Co. tank trailer, reducing carrier weight to 11,000 lb.

and still mostly in trade publications—has corrosion been aired as a problem in passenger cars. Yet, I would venture to say that a good 70 per cent of all cars that go to the junk yard land there, not because of mechanical failure, but because of the rusting out of the body. In contrast, the first FRP Corvette body we produced in 1954 is still in prime condition—underbody and all—and it hasn't been sitting in a museum. Thus far it has clocked over 125,000 mi., often trailering a boat. Its body has been repaired a few times when high bumpers hit it very hard, but no one could ever tell this from the outside.

Any discussion of reinforced plastics in transportation usually starts off with speculations on, and promotion of, its use for the bodies of additional production models. Even at the 10,000-a-year level, the Corvette represents sales of between 3½ and 4 million lb. of molded fiber glass. At the 25,000- to 40,000-unit level, up to which a fiber glass body now has a cost advantage over sheet metal, a single additional body of the size of the Corvette would boost use another 12 to 16 million lb.

The all fiber glass car body is eye-catching and its potential vast, but a variety of smaller applications consumed greater poundage in the past year. One of MFG's current jobs is the front seat side shields for the Lincoln Continental. Here molded fiber glass proved superior to nonreinforced plastics because it has the structural strength to withstand the oft-repeated pull of back seat passengers as they hoist themselves forward by the seat backs in getting out of the car. As compared to metal, the reinforced plastic provided enough flex combined with strength to make assembly quick and easy. Again, this is an application dependent upon reinforced plastics' unique structural strength. There are other areas in today's cars that could be similarly treated to achieve savings that would more than compensate for the cost per pound of resin and glass, the slowness of the molding cycle, and the labor cost per unit that presently limits use of reinforced plastics in the mass production cars.

A sampling of other present passenger car uses of molded fiber glass would include interior trim, like the parts we produce for the Cadillac 7-passenger limousines and the instrument panels we mold for Studebaker Hawks. Ford also utilizes reinforced plastics for the trim panels on its Econoline bus. The Econoline is half way between a passenger car and a commercial vehicle and its considerable sales volume is translating the $34.00 of trim panels we mold for each unit into a total of several hundred thousand dollars per year. The Cushman Truckster, Mailster, and scooters are also fabricated

Photo courtesy MFG Body Co.

FRP is specified by the White Motor Co. for construction of its Series 500 cabs.

of fiber glass, and represent a considerable share of current applications.

In the main, present uses of molded fiber glass by car and truck builders can be attributed to savings in tooling costs, savings in weight or improved performance in parts similar to the metal parts they replace. There are encouraging signs, though, that the transportation field is recognizing a fourth reason for reinforced plastics use—performance characteristics not available in other materials. At the same time, the cost picture continues to shape up on the side of molded fiber glass. Whereas over the past 6 years the prices of a representative group of reinforced plastics parts have been reduced 28 per cent, steel prices have gone up more than 30 per cent. Production continues to speed up, too. Improved raw materials and equipment are primarily responsible for these advances.

Trucks and Buses

Thus far, the discussion has centered on the uses of molded fiber glass in the passenger car field where, as a structural material, it starts with the handicap of something less than mass production capabilities.

When it is a question of truck and bus application, however, fiber glass has all the advantages. Here, in-

dividual company output is well within the volume where molded fiber glass affords clear-cut cost production savings. Here, too, there are dollars-in-the-pocket savings to be derived in higher payload and lower maintenance and repair from the material's light weight, corrosion resistance, localized accident damage, and ease of repair.

The Automobile Manufacturers Association reports sales last year of 1,190,319 trucks and 4162 motor coaches. Since from 42 to 47 per cent of the reinforced plastics in transportation in 1960 went into commercial vehicles, this means that an average of from 14 to 17 lb. of molded fiber glass was used per vehicle. This is approximately four times the amount estimated for average passenger car use, but far from what it should, and will, be.

There are a number of newly introduced truck and trailer components which could provide a quick, substantial boost in this use figure. Liners for refrigerator trucks and trailers are one example.

Not only do refrigerated haulers have a weight problem, but they also have trouble with air leaks and payload cube. The MFG Body Co., for one, has recently introduced panels designed to meet and solve all these problems. The panels have high impact resistance and, if damaged by a forklift truck, can be easily repaired without the necessity of removal. Because the material is a good insulator, the panels serve to provide more interior space and help solve the problem of payload cube. Furthermore, they can be steam cleaned, and the design of the panels is such that several overlap and can be fastened to studs by screws, rivets, or adhesives.

Here, of course, there is a replacement as well as an original equipment market. I believe truck fenders could develop a similar double market—also tail light housings and corner skirts. The New York Transit Authority, for example, has found that the curved front and rear skirts of its buses are both less subject to damage and easier and cheaper to repair, if damaged, when made of reinforced plastics. To date, about 500 of these corner sections have been installed.

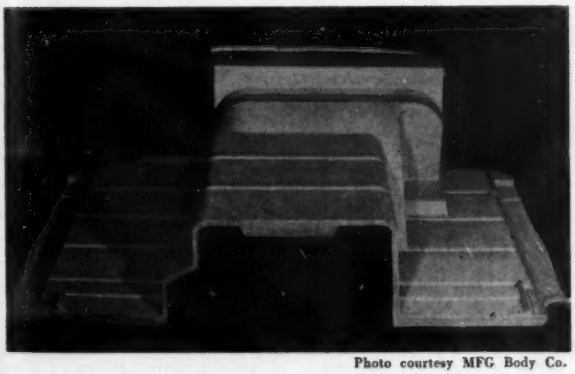


Photo courtesy MFG Body Co.

White cab underbody illustrates how closely FRP can be molded to contours of engine parts.

New York City buses provide one of the most rugged tests for a material, and fiber glass reinforced plastics have come through with flying colors. The best documentation is on bus seats. With 925 of its 2150 buses equipped with molded fiber glass seats, the Authority finds that the annual cost of seat repair goes down in direct proportion to the increase in the number of buses in which these seats are installed. By 1965 it hopes to be fully converted from upholstered to reinforced plastics seats and to have virtually eliminated seat repair from its maintenance budget. This was running to $200,000 a year before the Authority started in 1957 to specify molded seats. In addition, reinforced plastic affords a weight saving of 20 lb. a double seat, or approximately 500 lb. per bus. In a vehicle that stops and starts on the average of 900 times during its daily run, this reduction adds up to considerable savings in fuel.

A few scratches on some of these molded fiber glass seats attest to the attempts, and failures, of knife wielding vandals. Lively youngsters jumping up and down on seats in the first order of 209 buses did manage to crack a few, due to inadequate front-edge support—a weakness that was quickly, and finally, corrected by shifting the steel framing to pass close under the front lip of the seat.

In contrast to this happy no-maintenance situation on the reinforced plastics seats, the Authority repairs an average of 12 upholstered bus seats a day, or 2700 seats a year. Both time and material are involved in these repairs. While some slashed upholstery can be patched, in a high percentage of the cases complete reupholstery is necessary since whole squares of the vinyl covering have been cut out, frequently to provide durable school book covers. In addition, the vandals pull out and remove the foam rubber padding of the seat.

There are yet other uses where the New York Transit Authority feels reinforced plastics might improve performance and eliminate or reduce maintenance. One is the rear engine cover where fiber glass would have the advantages of resistance to bumps and bangs, light weight, corrosion resistance, and ease of repair that recommend it for the bus skirts.

This type of use—partnership with metals—has a potential that, to date, has barely been touched. The

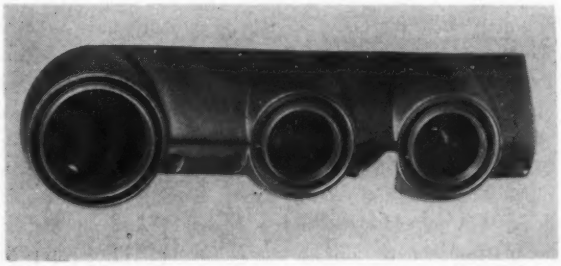
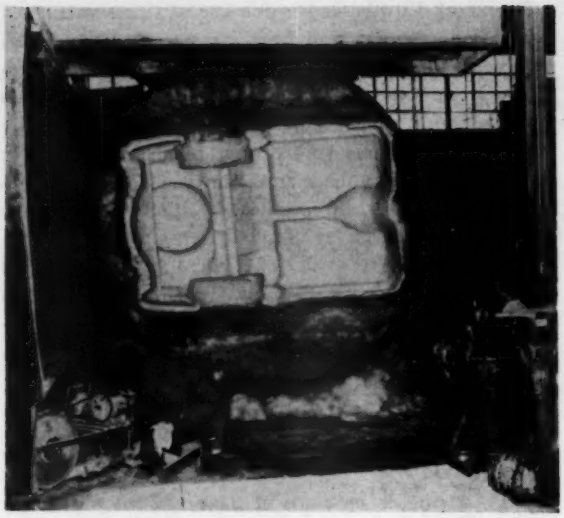


Photo courtesy MFG Body Co.

Tail light housing fabricated of FRP.



Molding of Corvette underbody: blowing of preform . . .

. . . preform being put into press . . .

parts we produce for Ford for its "H" series tilt cabs are an interesting example. Ford uses molded fiber glass lower body front panels, lower body side panels, and an upper grille bar to convert a volume production metal cab to a lower volume cab-over-engine style. The aluminum finish on the parts also gives evidence of the advances made in finishing of reinforced plastics.

Perhaps the best documentation of the advantages of fiber glass reinforced plastics in transportation has come from the White Motor Co. relative to the all-reinforced plastics cab on its Series 5400 truck-tractors. The regular cab comprises 36 molded fiber glass parts; the sleeper cab, 8 more molded parts. White presents the following as the principal advantages of reinforced plastics, listed in the order of their importance: *(1)* weight savings, *(2)* lower tooling cost, and *(3)* nonrusting properties and ease of repair.

Taking the question of weight first, there is a 200-lb. saving with fiber glass cabs as compared to steel cabs. We have estimated that for the one-piece underbody which measures 95 in. by 50 in. by 30 in. deep, tooling cost is $39,000. In steel, this underbody, which would need to be an assembly of a number of parts, would cost in the neighborhood of $240,000.

There are driver comfort advantages to a fiber glass reinforced plastic cab, too, White Motor Co. found. It is warmer than a metal cab in winter, and cooler in summer, since the material does not absorb heat as does metal. Again, a molded fiber glass cab is quieter. This is partly attributable to the fact that the material muffles engine and road noise and that it eliminates squeaks and rattles. There is more room for the driver, too, because molded fiber glass can be shaped to conform more closely to the engine parts. This is of particular advantage in cab-over-engine design where an engine compartment runs longitudinally through the center of the cab. Finally, White has reported that molded fiber glass parts, like the "dog house" that covers the engine, are more rigid and stronger than those of metal because of their one-piece construction.

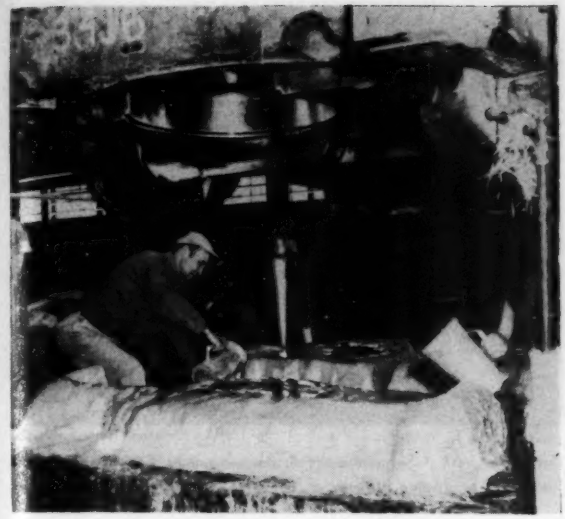
In these parts, as in others, it must be emphasized over and over again that there are two aspects to every successful fiber glass reinforced plastics application. One is the material itself; the other, how it is used—the particular balance of ingredients, and the way they are made into a finished product.

Take, as an example, roll-up overhead doors on beverage trucks. Resistance to denting and insulation of the interior from the heat of summer and the cold of winter are properties of the material itself. However, continued flexibility that assures repeated, easy raising and lowering results from the specific formulation and fabrication of the material.

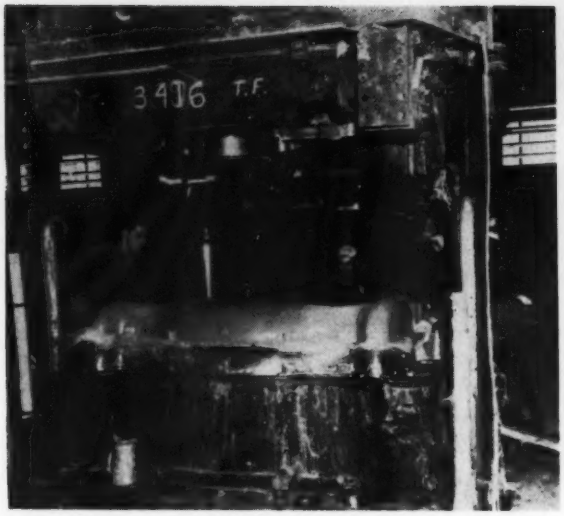
Research, Development, and Testing

In both commercial vehicles and passenger cars, full attainment of the great potential for fiber glass plastic requires not only imaginative use of the materials by Detroit engineers, but intensive, sustained research and development work on the part of the reinforced plastics industry both in materials and equipment. During the past year MFG, for example, spent just over $1 million on new capital items such as equipment, buildings, tools, research, and testing facilities. About half of this investment went into expansion of production capacity; the other half into equipment which would lower costs and improve quality. Equipment that was installed new in 1954 was scrapped during 1960, even though usable, and replaced by more efficient machines. This investment is equivalent to 9 per cent of our total 1960 sales, and will be followed up during 1961 with a capital expenditure of more than $500,000.

There are not nearly enough facilities today for research and testing at the processing level, yet it is here that all the material and processing variables come together and the effect of their interaction can actually



. . . resin being poured in even, full distribution . . .



. . . and fully molded form being removed from mold.

be observed and evaluated. With over four years of experience behind it, RECO, the MFG research center, currently includes in its operations a chemistry laboratory, exposure laboratory, physical testing laboratory and quality control laboratory. Work at the research center concentrates on several objectives.

1. To find the best materials for each specific product. This may involve simply the choice of reinforcement and standard resin, or it may require modification of an existing resin or even development of a new resin.

2. To find the best molding technique for a product. Each product presents individual requirements and processing problems, and the laboratories help to determine the optimum molding temperatures, cure time, pour pattern, and assembly and finishing techniques.

3. To make sure the product is suitable for its proposed end use, whether the product is custom or proprietary. It might be found that a part needs special reinforcement, thicker section, veil, special resin, filler, pigment, or special molding techniques.

4. Materials quality control for all components. Every shipment of reinforcement, resin raw materials, resin, pigment, or filler is tested to meet specifications.

5. Product quality control. Actual production units are taken periodically from the processing line and subjected to thorough testing.

6. To develop a data file of test information. This serves as a time-saving guide, permitting the engineer to select quickly the combination of materials and construction likely to meet a product specification. Special tests are then run to determine whether the selected materials are best for the current project.

The importance of such work at the processor level has been proven repeatedly. The reverse impact test run on all panels made with veil, simulating the effect of a stone thrown up against a fender or underbody, has made possible the production of parts that will sustain such blows, without serious fracture and surface marring. The results here have been significant in work on the Chevrolet Corvette, White truck cab, Ford truck cab parts, and other automotive body applications.

One development program with potential importance to the transportation market is the bonding material project. In this case, a special section has been set up to test both production workability and final physical properties. The project was instituted to work for continuous improvement of assembly of Corvette bodies and White truck cabs, but will be equally valuable for any product involving assembly of many reinforced plastic parts. The ideal bonding material should stick readily on application, yet must be pliable and workable. It must not flow at room temperature. These qualities are the first tested. To determine the strength of the bond, RECO currently runs a shear test and has recently devised a new test that yields even more significant data. Two 1- by-3-in. pieces are bonded as a cross, then put in a fixture that grasps the four unbonded ends and pulls the pieces directly apart with calibrated force. Finally, bonded assemblies are tested for hair-line cracks, using a standard flexural test. Actually, the hair-line crack has no effect on the strength or durability of the bond, but since it may worry the customer, MFG has worked to eliminate it. In the flexural test, load is increased and deflection recorded until the sample breaks.

Last year, transportation was the market that registered the greatest increase in sales of reinforced plasics. The forecast by the reinforced plastics industry, released last January, was for an 11 per cent increase for 1961. In spite of the fact that the first quarter of 1961 was quite low in the general automotive and truck field, the projected increase is expected to be exceeded by the end of the year.

Photo courtesy Hatteras Yacht.

This 41-ft. sports fisherman is the first cruiser of its size made of fiber glass on a production basis.

Fiber Glass in Recreation

by Don W. Lyon

Manager, Textile Glass Sales, Johns-Manville Sales Corp.

Just mix sand, soda ash and other ingredients according to a "secret" formula, bring them to a molten boil, draw them into strong fibers of glass, combine them with plastic—and you have one of the most versatile materials ever known to man.

If you really like fun, if you enjoy skimming the waterways, knocking down par on the golf course, skin diving and spear fishing, camping, whisking down a sled run, swimming the pool length a couple of times before breakfast, the chances are fiber glass will be helping you. Or maybe baseball is your sport, or the horses coming into the stretch, or taking the kids to the playground, or trying for that 300 game. In recreation items, plus all the other products where fiber glass reinforced plastic plays an important role, our official forecasters say you'll use over 270 million lb. in 1961.

BOATS

As a fiber glass boat owner, you're one of millions. Today's boating industry is the number-one recreational user. Last year 56 million lb. of fiber glass reinforced plastics were consumed by 217 manufacturers of boats. This poundage, in fact, ranks boating first among all usages in the fiber glass-reinforced plastic field, leading the second-place construction field by 12 million lb.

The rise of fiber glass in boating has been spectacular. It was only a decade ago that hardy manufacturing pioneers—and their adventuresome customers—put rugged first models through their paces. Now, when you see two boats together, chances are one of them is fiber glass. Year after year at the boat shows, an increasing percentage of all craft on display is made of this new marine material. The New York National Motor Boat

Photo courtesy Zenith Plastics.

Long Beach, Calif., marina introduces free-floating, flexible system of durable fiber glass pontoons.

Show for 1961 featured 494 boats of all sizes and types. Fiber glass models accounted for half of these—50.8 per cent to be exact. If show statistics prove to be an accurate forecast of things to come—and they always have—then 1960's record-breaking fiber glass production of 155,000 units will be easily eclipsed.

And veteran boating observers predict that fiber glass will continue to gain dominance in all sizes—up to and including 40-, 50-, and 60-ft. cruisers and sailboats—in less than 5 years* These experts believe, too, that even "old school yachtsmen," long accustomed to wood construction, are now accepting fiber glass as a superior material that has earned its way in the marine field.

That boat buyers have accepted this new material in a big way is clearly indicated by these production growth facts: 1953—5000; 1957—50,000; 1958—85,000; 1959—130,000. We believe that fiber glass production will hit the 300,000 mark by 1964, claiming a solid 65 per cent of total boats built.

And not all of this will be registered at the expense of other materials. A good part of it will come from the increasing popularity of boating itself all across the country. To meet the demand, fiber glass boat builders are giving the public a wide choice of pleasure craft.

During the early years, while the quantity of fiber glass boats moved ahead, so did quality and full-line availability. At the start, only small runabouts were available. Then, as fiber glass and plastic resin manufacturers, weavers, and other suppliers worked closely with boat builders, new design and production techniques were developed. Almost automatically came an increase in sizes and types of fiber glass craft; today there is virtually no limit. Outboard and inboard runabouts, canoes, rowboats, catamarans, inboard and outboard cruisers, sailboats—all are being made of fiber glass.

These boats are virtually indestructible. They won't rust, rot, or corrode. They don't need sanding, scraping, or caulking. Only minimum maintenance is necessary. Design flexibility with fiber glass permits smart styling, guided, of course, by seaworthy designs. Deep, molded-in colors stay showroom-fresh for years. Many leading insurance companies have started giving favorable rates to fiber glass boats, because these boats suffered far less than other types of craft during Hurricane Donna on the east coast last year. In case of minor damage, caused by hitting a dock too hard, for example, patching is fast and easy with one of many fiber glass kits available.

Manufacturing Methods

Four principal methods of fiber glass boat construction are in use today: (*1*) molding by matched metal dies, (*2*) pressure bag, (*3*) vacuum bag, and (*4*) spray-up and hand lay-up. The last method is most widely used.

* Last month a 67-ft. fiber glass motor yacht was launched at East Boothbay, Maine. The 15,000-lb. hull was molded in one piece by Halmatic, Ltd., in Portsmouth, England, and fitted out at the Hodgdon Brothers boatyard in Maine.

Photo courtesy Cincinnati Milling.

Molded fiber glass bowling alley settee provides perfect alignment for fast, easy installation.

Photo courtesy Cincinnati Milling.

For those who prefer to relax, fiber glass can serve as here in the chair, radio-stereo and T.V. units.

Lapped-over layers of fiber glass woven roving, fabric and mat are hand laid into a sturdy fiber glass mold. Each layer is "wet out" with plastic resin, squeegeed into position, and allowed to cure between each operation. The final laminated boat hull, deck, or part results from the natural "set-up" of the layers of fiber glass and resin. At Johns-Manville, the chief contributions to the boating industry include 'Garan' woven roving, and new Garanmat and gun roving. When it comes to speeding up production on the line, materials which "wet out" rapidly with plastic resin are important time-savers.

A major share of the fiber glass boat market is claimed by outboard runabouts and cruisers. Much of America's vast boating population, estimated at 40 million persons, depends on portable power in the form of these boats.

As boats increase in size, motor manufacturers keep pace by introducing larger horsepower units. Many motors have fiber glass reinforced plastics for motor covers or "shrouds." Big 75- and 80-hp motors can mean a lot of "roar," but by using fiber glass shrouds, one leading manufacturer has achieved good sound control. Flat "talking" surfaces and abrupt angles are virtually eliminated, so that the cover's graceful lines form vibration-free sound diverting curves. Fiber glass' workability and its ready fabrication into all shapes make this important innovation possible.

WATER SKIING

One reason—or perhaps one million reasons — for the push for more boating speed is that approximately a million persons enjoy being pulled by a long line, attached astern, as they zoom along on water skis. This fast-growing on-the-water sport, with the number of participants expected to quadruple in the next four years, also finds fiber glass-plastic in popular usage.

Actually, the big, powerful motors helped lead to water skis made of fiber glass. Early research proved that shorter, lighter weight skis would maneuver and control better at the new high speeds. It was discovered, too, that tapering both ends of the ski, combined with a "rocker bottom" and an aft end fin, would further improve the skier's ride and control. Fiber glass made these design changes relatively easy.

Though water skiing was invented in 1928, with a fearless rider mounted on a pair of lashed-together wood snow skis, the sport didn't begin to boom until fiber glass types emerged from factories and shops across the country. These brightly decorated water wonders also are considerably safer than their old-fashioned predecessors because they're rugged. They won't shatter, chip or warp. And every molded fiber glass ski is an exact duplicate.

MARINAS

One of the most spectacular uses of fiber glass is the 1800-boat marina at Long Beach, Calif. Under municipal management, authorities are utilizing floating fiber glass-plastic pontoons. They resist corrosion and electrolytic decay long suffered by salt-water marinas, and they are easy to install and keep free of sea urchins and other parasites. Tidal waters find the pontoons strong and durable.

City officials primarily chose fiber glass because of the comparatively low cost of the system. The pontoons provide the economic advantage of maintenance-free flotation plus the physical advantage of mobility—they can be moved, quickly and easily, to suit the needs of marina expansion. With demand for boat space multiplying rapidly, even this large marina will face expansion problems the very day it's completed! Three thousand applications for slips were on hand in mid-1960.

SKIN DIVING

Skin divers are now using hand spears with solid core fiber glass shafts. Tough, strong, lightweight, easy to handle, they come in tapered lengths up to 90 in. long.

BOWLING

Walk into the modern bowling alley and you're literally surrounded with fiber glass. Chairs, seats, benches, and ball returns have beautiful colors molded in; they are smoothly contoured and extremely comfortable. The benches, for example, are made in modular units that are dimensionally accurate so they align perfectly for quick installation. Bowling alley operators recognize fiber glass equipment as being the most rugged and serviceable they've ever known.

ARCHERY

While fiber glass has registered impressive gains over conventional materials in many sports fields, there's one in addition to fishing rods in which it has completely riddled the opposition. Almost all archery bows use fiber glass-reinforced plastic backing and facing strips laminated to wood cores.

Fiber glass-plastic laminates began to be used about a decade ago. The results were greater resiliency and finer accuracy than ever before known, and bow was just as "fresh" after many thousands of shots as the day the first arrow touched the bowstring. Archers discovered, too, that fiber glass bows pulled "truer" every time—without the troublesome adjustments formerly needed with "tired-out" all-wood bows.

As represented by the sale of equipment, archery is the fastest-growing sport compared with the movement of other sporting goods. These are an estimated 5,220,000 archers in the United States, only a few thousand less than the golfing population. Many participate in organized activities sponsored by over 1800 local, state and regional clubs. Bow hunting, lured by favorable state laws, has reached astounding proportions. In 1959, for example, Michigan registered 65,000 hunting licenses to archers, and Pennsylvania had 75,000. In most states, bowmen are permitted to shoot 30 days before and 30 days after firearm permits are valid. And though they're

Photo courtesy Cushman.

Photo courtesy Sila-Flex.

Photo courtesy
Los Angeles Times News Bureau.

Photo courtesy Creative Playthings.

Fiber glass is well-known to the modern archer, and has recently made its appearance in motorized golf carts, springy poles which threaten to topple previously set vaulting records, and safe, fast slides for the kiddies.

allowed to hunt during the gun-toting season, too, you won't find many taking advantage of this rule!

Almost all of the hunters join nonhunters at target shoots. One of the most popular tourneys is sponsored by the National Archery Association of the United States. At its 76th annual meet held last August on the Miami University campus in Oxford, Ohio, every participant—252 men, women, boys, and girls—used a fiber glass-plastic bow.

Pioneer developers of fiber glass-plastic laminated bows—many of whom today are major manufacturers—say that archery really began its galloping growth era when fiber glass was added to the bow. Fiber glass also is claiming an ever-increasing share of the bow's companion product, its "missile" end—the arrow. Shafts of fiber glass reinforced plastic tubing are proving popular with archers because they're permanently straight, won't warp or set, and are uniformly light weight.

GOLF

You can ride around the course in one of the new, quiet fiber glass golf carts—thick, sound-absorbent fiber glass insulation isolates the engine noise.

If you are not already using them, you should try golf clubs with fiber glass shafts. There's a balance to them that you don't seem to get with other materials.

CHILDREN'S PLAYGROUND

You'll most likely find "miraculous" fiber glass at the playground, too, in the form of slides with unusual shapes, climbing rigs, and swing-arounds.

Out in front of the super-market there will probably be a fiber glass kiddie-ride horse, or a miniature tugboat, or a rocket ship which, for a dime, will give the kids a world of adventure.

SWIMMING POOLS

There are at least three kinds of pools involving fiber glass-plastic which can be installed in the backyard—(*1*) the shell, (*2*) panel or (*3*) spray-up type—all of them impervious to moisture, with color molded in, requiring minimum maintenance.

In the shell type, you dig the basic hole to prescribed dimensions, set in premolded fiber glass-plastic shell

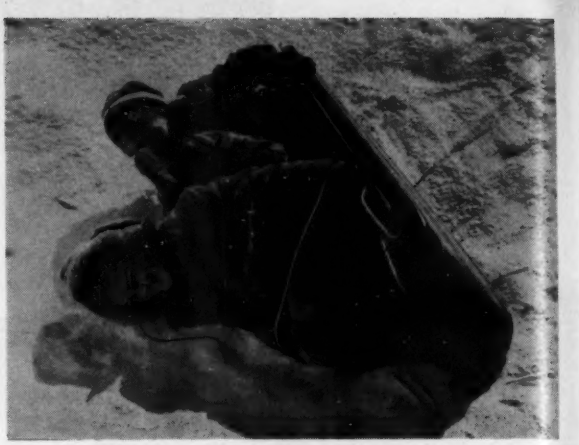
Fiber glass has a happy way with home swimming pools, both at the time of installation and during maintenance. Shown here is panel type.

sections to make up sides and bottom, fill the joints with mastic, bolt the sections together, hook up drains and filling and filtering mechanisms, add water; and that's it. But don't forget the back fill.

The panel type is nearly the same except that fiber glass panels line the sides of the pool and you fill the bottom with concrete which you later coat with sprayed-on fiber glass and plastic. Add the other accoutrements, and the pool is ready.

Sprayed-up fiber glass is for both new and older pools. If you build the basic pool with concrete block side and concrete bottom, you can have a spray-up expert come to poolside and with his special equipment and new fiber glass "gun" roving. He will spray a thick layer of colorful, durable and long-lasting fiber glass-plastic which is also impervious to moisture. He can do this to your older pool, too, and you'll never have to worry again about painting or caulking.

That "bouncy" diving board you see at many a pool is fiber glass. These boards retain resiliency for years of active use—and their bright hues add sparkling new dimensions to the scenery.



When winter comes, fiber glass will be right there providing sledding fun for the younger set. And no more worries about metal runners, either.

The same qualities are available in a full line of poolside fiber glass patio furniture that you can leave outside in all kinds of weather—chairs of many sizes and shapes and colors, and sun lounges with sit-up or lie-down backs.

WINTER SPORTS

Strictly wintertime are the fiber glass sleds and saucers that have caught the fancy of kids and grown-ups alike. Toboggan-type models are rugged, slide beautifully down the snowy slopes, and their one-piece construction eliminates the metal runners that have often been dangerous.

On ski runs all over the country, you'll see the new lightweight, fiber glass ski poles that are easy to handle

Photo courtesy Amercoat.

Nag's-eye view of the new fiber glass race track rail with color molded in.

and have the toughness for supporting the skier's body weight as he twists and turns down the slalom course. The shaft of this new ski pole is a tubular fiber glass laminate that gives more strength for its weight than any other known shaft. It won't fail under loads which will collapse or permanently bend other light weight shafts. Like all materials, though, it is not indestructible. If failure does occur—and this may be caused by ex-

.reme impact blows like being smashed against sharp angles of the lift towers—the fiber glass shaft will not shatter into dangerous fragments or spikes which are common to other ski pole materials. The actual strength of the pole exceeds all normal skiing requirements and remains constant well below –30°F.

BASEBALL

Let's not forget the national passtime. You have a little guy in the Little League? Then you know all about lightweight fiber glass-plastic protective caps that provide complete head protection. They are used in the major leagues too.

Photo courtesy Specht Plastics.

When Junior goes to bat, he is now protected with a sturdy fiber glass baseball cap in his team's color.

RACE TRACK

When you go to the races, you might pass right by the fiber glass race track rail without noticing it, but the manufacturer would tell you the railing is impervious to weather, never needs painting because the color is molded in, and can't splinter and injure a spectator or one of the thoroughbreds racing along its edge.

Interesting test he put it through. Two 10-ft. sections were installed on steel uprights and a large rubber-tired tractor was backed into it. The railing bent about 6 in. out of line but sprang back to its original position when the tractor pulled away.

Another new fiber glass product at the track is the whip, of which there are many in use around the country urging trotters, pacers, and racers down the homestretch. The fiber glass rod never takes a "set," and it stays straight, willowy, and useful.

SPORTS CARS

In the sports car field, fiber glass has played an important part as reinforcement for plastic bodies. Well-known is the Chevrolet Corvette, now over 7 years old.

Fiber glass has opened the way to the enthusiast who likes to custom-make his own bodies with streamlined contours that have never been possible before. He finds the material easy to work with right in his own garage and he needs no special tools.

MOBILE HOMES

There are so many sizes and styles of mobile homes and trailers that we couldn't begin to list them here. They are made with fiber glass panels, fiber glass awnings you can put up, packed front-to-back with fiber glass blanket insulation for comfort and maintenance is at a minimum.

CAMPING

There are many kinds of tents, but there's one, for example, that fairly jumps to attention. Its tent frame is made of fiber glass-plastic rods that bend into "collapse" position easily, never take a "set", and pop up spring-tight, ready for pitching the tent.

If it weren't for the fiber glass rods, this tent design would not be possible.

FISHING RODS

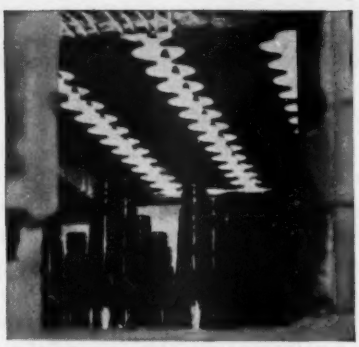
Libbey-Owens-Ford Glass Fibers Co., a predecessor firm to Johns-Manville Fiber Glass Div., played a major role in moving the fiber glass fishing rod along by turning over to the fishing rod industry one of the basic patents for making them. Today, over 95 per cent of the rods are made of fiber glass.

The variety is relatively infinite. Trolling, casting, fly, outrigger, and a new tubular, telescopic fiber glass fish rod. This last you carry like a cane, and, when ready, uncap one end, whisk it forward as if you were casting, and zip! There's your fish pole, 12 ft. long!

The serious aspects of fun-loving fiber glass—its basic properties—give an insight into its great potential. It possesses the highest tensile strength-weight ratio of any commercial material occurring in nature or synthesized by man—and that includes steel. It has remarkable dimensional and physical stability. Though fine as gossimer, the individual fibers are actually microscopically thin glass rods. Because they have no cellular interstructure they cannot absorb moisture. The fibers, therefore, cannot shrink, stretch, or swell. Fiber glass itself is completely noncombustible. It cannot oxidize; its basic elements are already in a complete state of oxidation. When combined with plastic resins it produces a basic material of unusual strength, one that is impervious to rot, rust, mildew, corrosion, electrolysis, and water absorption. Considering these unusual properties, there are perhaps more applications for fiber glass than will ever be fully exploited.

Historians may well record fiber glass as the "wonder" product of this era. It has already been recognized as an important material with many uses, not the least of which is giving pleasure to millions during their moments of leisure.

NEW SLANTS ON HEAT PROCESSING FROM SELAS



Selas DURADIANT *roof panel, only 2 ft. long, installed into preheat section of a conventional lehr, increased ware production rate up to 50%.*

SELAS CORPORATION OF AMERICA
146 Dreshertown Road, Dresher, Pa.

SELAS

HEAT AND FLUID PROCESSING ENGINEERS
DEVELOPMENT / DESIGN / CONSTRUCTION

By simply installing a Selas DURADIANT® burner roof panel into the preheat section of your existing lehr, you can significantly increase output . . . without adding so much as an inch to the length of the lehr. Over 40 installations have been made increasing production rates up to 50%!

By heating the ware directly from the top of the lehr —instead of overheating the conveyor from below— the Selas principle of direct-gas-fired, radiant-booster heating improves the performance of your existing lehr in other ways, too:

- Improves uniformity of anneal . . . minimizes ware breakage.
- Increases conveyor belt life.
- Saves valuable floor space.
- Permits wider variety of ware to be annealed in your existing lehr.

At your convenience . . . without cost or obligation to you . . . a Selas field engineer would welcome the opportunity to show you how DURADIANT roof panels can be adapted to your glass annealing and decorating requirements. For this personal service—or a copy of our new Bulletin "Processing Glass with Selas GRADIATION® Heating"—write to Mr. C. P. Mann, Manager, Oven, Dryer and Lehr Division.

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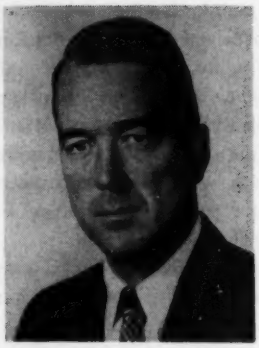


William J. Clark

William J. Clark

Formerly vice-president and corporate advertising director, new vice-president, reinforced plastics marketing division, Owens-Corning Fiberglas Corp. He succeeds W. M. Keller, now on special assignment reporting to W. H. Curtiss, Jr., vice-president, marketing. Benjamin F. Leaman, Jr., becomes corporate advertising director.

Frederic L. Purtill and Guy O. Mabry have been appointed vice-presidents. Mr. Purtill is vice-president, marketing, of the Pacific Coast division, with headquarters in Santa Clara, Calif., and Mr. Mabry, vice-president, Southeastern region, with headquarters in Atlanta, Ga.

William W. Boeschenstein, vice-president of Owens-Corning Fiberglas, is now head of the corporation's sales branch operations with headquarters in Toledo.

Thomas E. Moffitt

Chairman of the board and chief executive officer, Hooker Chemical Corp. Succeeding him as president of the company is F. Leonard Bryant, former executive vice-president. Thomas F. Willers moves from his post as a vice-president to become executive vice-president of the firm.

Harold Hofreiter

Sales manager, Panel Structures, Inc., for the complete line of "Sanpan"* translucent wall panel products. He was formerly district manager of Ludman Corp., regional manager for Miami Window Corp., and vice-president of Sash., Inc.

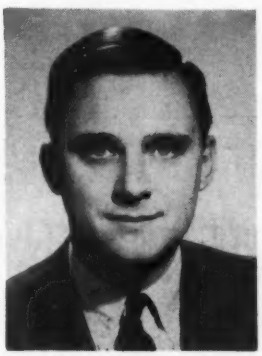
*See THE GLASS INDUSTRY, 42, 148 (March).

Johns-Manville Fiber Glass Div.

Is expanding its operations at Parkersburgh, W. Va., by adding equipment to manufacture fiber glass home insulation, a new product line. This is the plant's second major expansion in recent months. In December J-M began a 100,000-sq. ft. addition of manufacturing space and equipment to increase production of fiber glass roving and mat. That program represented a 38 per cent increase in plant size, making the Parkersburg plant the largest fiber glass manufacturing facility operated by Johns-Manville.

Northern Fiberglass, Inc.

Has appointed Bob Wolf, Aurora, Col., as manufacturers' representative for the territory covering Colorado, Wyoming, Utah, and New Mexico.



William W. Boeschenstein

Durkin Chemicals, Inc.

Named distributor for fiber glass roving, chopped strand mat, and milled fibers by Johns-Manville. The firm, which also sells allied products (polyester resins, catalysts and polyurethane foams) will represent J-M in the entire Pacific Northwest area.

Fire Destroys Fiber Glass Plant

The Fiberglas Enterprises, Inc., plant just north of Grand Forks, S. D., was destroyed by fire early in March. Constructed 2 years ago at the cost of $30,000, the facility served in the production of fiber glass boats, tub and shower units, liquid fertilizer tanks, and other similarly processed custom products.

George B. Price

George B. Price

Senior research engineer in the technical department, Johns-Manville Fiber Glass Div., Waterville, Ohio.

Owens-Corning Fiberglas Corp.

New textile yarn manufacturing plant at Aiken, S. C., was selected by Factory Magazine as one of the 10 best American industrial plants constructed in 1960.

Masterpieces in Glass

Is the theme selected by the Fiber Glass Division of Pittsburgh Plate Glass Co. for a major fall promotion. At that time the company will feature drapery fabrics and ready-made draperies of PPG fiber glass in conjunction with a collection of paintings in glass. This exhibit will be presented to the trade, as well as to the general public, in regional showings throughout the United States.

To dramatize the decorative and artistic potential of fiber glass, the company has acquired a representative collection of Gemmaux—French masterpieces in colored glass, including works signed by Picasso, Braque, and Jean Cocteau. The Gemmaux represents a new art form, in that the small particles of colored glass are used in much the same manner that an artist uses oil paints.

Among the converters and manufacturers who are styling fabrics for the promotion are Covington, Qual Fab, Cameo Curtain, Waverly, Bonnie Looms, Ludeman Fabrics, Oxford Drapery, Cortley Mfg., A. W. Scheffres, and Flamingo Fabrics.

FIBER GLASS APPLICATIONS

AIR-CUSHION SKIS now being produced in France are made of fiber glass impregnated with synthetic resin and polymerized around two plastic tubes filled with compressed air. The responsive lightness of these new skis is expected to increase speed and precision in slalom races considerably, and to lend ease and confidence to beginners on the slopes. *Rossignol Co.*

Reader Service Card: Circle No. 50

COMPACT ELECTRICAL CAR, designed specifically for industrial service, features a one-piece molded fiber glass body. The 3-wheel car will carry the operator and loads up to 100 lb. or an additional passenger.

The 12-volt electric motor is operated by a foot switch, and the 12-volt lead-acid battery is equipped with a trickle charger. Forward speed of the car is factory set at 5 mph. The fiber glass body comes in safety orange, desert sand, mint green, and Mediterranean blue, and requires a minimum of maintenance. *Namisco, Inc.*

Reader Service Card: Circle No. 51

LAY-IN ACOUSTICAL PANELS of fiber glass have been developed for low-cost, easy-installation ceiling construction. Their 3-layer fabrication provides high noise-killing efficiency, and the panels themselves are noncombustible.

The front surface is under constant tension, the back surface under constant compression, and the center forms a porous, sound-absorbent glass fiber blanket. The result is a smooth, taut ceiling that will not sag, and during installation the panels can be easily cut or bent without breaking. They also add thermal insulation when located directly under the roof slab. Vacuuming or wiping with a damp cloth will clean the panels sufficiently, and they can be repainted, if desired, without any appreciable loss in sound absorption.

The panels can be lifted out for complete accessibility to above-the-ceiling services and utilities. These qualities make them ideal for large open areas such as super markets, bowling alleys, restaurants, schools, auditoriums, and manufacturing facilities. *Johns-Manville Corp.*

Reader Service Card: Circle No. 52

FOOD HANDLING BIN fabricated in one piece of fiber glass reinforced plastic is now available for sorting, processing, storing, or moving food and other bulk products. Molded in a solid form by a giant 700-ton press on matched steel dies, this new bin is low in initial cost, rust- and corrosion-proof, and quick and easy to clean. It weighs only 130 lb. and has a capacity of 33.5 cu. ft. or 260 gal. *Tee-Pak, Inc.*

Reader Service Card: Circle No. 53

HANDBOOK OF GLASS MANUFACTURE

VOLUME I Third Printing (Just Published)

The continued demand for this book proves its lasting importance as a basic source of information on glass manufacture and as a practical working tool for glass plant executives, research heads, engineers and technologists.

VOLUME II . . .

Bridges the Gap Between Theory and Practice, in Glass Manufacturing.

Orders for both Volume I and Volume II are being filled NOW.

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Optical Properties

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VERTICAL LOUVER BLINDS of vinyl-coated fiber glass have been installed in the main passenger terminal at St. Louis' Lambert Field airport. A total of 7,900 yd. or about 4½ mi. of blinds of varying lengths conform to the semicircular shape of the vast window areas. Fiber glass was chosen because it is dimensionally stable and will not stretch or shrink.

The shade cloth, called "Tontine Triglas", is claimed by the fabricators to test three times stronger in breaking strength than the best quality conventional cotton based shade cloth. It is also said to possess substantially higher tearing strength and unusually high resistance to aging and discoloration. *Hessler Vertical Blind Co.*

Reader Service Card: Circle No. 54

NONWOVEN TAPE made of high-tensile glass yarns bonded with thermosetting resins is now being used to hold windings in armatures and wound rotors against the effects of centrifugal force. Because it is nonmagnetic and self-insulating, provides steel-like tensile strength, and is easier, faster, and safer to apply, this glass fiber tape is currently replacing steel banding and wire in many applications.

Since its introduction in 1956, "Res-i-glas" has found an increasing number of uses in generators, power shovels, steel mill and diesel locomotive traction motors and generators. Recently it has been adopted by U.S. Steel Corp. and The Pennsylvania Railroad for armatures.

Because it is not woven, the tape utilizes the full tensile strength of glass and has high modulus, low elongation, and high impact strength properties. In use, this tape allows a 13 per cent saving in materials and a 90 per cent saving in labor costs. *Chicago Printed String Co.*

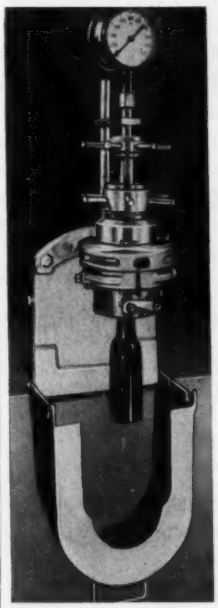
Reader Service Card: Circle No. 55

CATALOGS RECEIVED

Nuclear Fuel in the Form of Glass Fibers. By K. Lustig. This paper is reported in a current issue of the Consultants Bureau English translation of the Soviet journal "Glass and Ceramics", Vol. XVII, No. 3, p. 42, March 1960. It proposes that nuclear fuel elements be made of glass fibers containing oxides of uranium, plutonium, or thorium. The principal advantages to this approach are chemical stability, thermal stability, and heat resistance which makes it possible to operate reactors at temperatures up to 1000°C. There are extensive possibilities for varying the content of fissionable material and using different types of fuel, and it is suitable for many different types of low-temperature reactors. Facility of continuous removal of fission products by the liquid coolant and replacement of fuel elements, and simplicity and low cost of production are also important features of this process.

Reader Service Card: Circle No. 56

HYDROSTATICALLY TEST BOTTLES IN SAFETY



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- BREAKING PRESSURE is recorded by a manual reset free pointer.
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- TESTING IS SAFE as bottle breaks inside safety shield with parts dropping harmlessly into container below.
- TESTING IS FAST as there are no weights to handle and the required operations are simple and convenient.

The TECO TESTER will test all sizes from 7/16" I.D. finish up to and including jars with 62 mm finish. Gallon jugs with maximum radius of 2" from center of closure to outside of handle. Finish heights ⅛" to 2½" long can be tested. Write today for descriptive literature.

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(Circle No. 28)

NEWS
IN THE GLASS INDUSTRY

Saint-Gobain Corp.

E. B. GENTIL, member of the board of directors, Compagnie de Saint-Gobain, died April 19 at the age of 81. He was a leader in the development of modern glass manufacturing processes and the founder of several companies here and abroad . . . Construction of the new Kingsport, Tenn., facility, which will make available an entire range of plate, sheet, and rolled glass from a single source, has neared half-way point. When completed, the plant will produce 40 million sq. ft. of plate glass a year.

Cambridge Wire Cloth Co.

OLNEY P. ROSS appointed head of the conveyor belt sales department and JOSEPH E. MCKNETT, head of the wire cloth department.

Corning Glass Works

AMORY HOUGHTON elected chairman of the firm's executive committee . . . WILLIAM C. DECKER to succeed Houghton as chairman of the board . . . AMORY HOUGHTON, JR., elected president . . . THOMAS S. WOOD, JR., formerly company director of purchases, now a vice-president . . . CHARLES D. LAFOLLETTE re-elected financial vice-president . . . DR. EUGENE C. SULLIVAN re-elected honorary chairman of the board . . . DR. WILLIAM H. ARMISTEAD, vice-president, appointed director of technical staffs . . . LEROY A. AMYLON, vice-president, to head the enlarged industrial relations division . . . JOHN L. WARD named to new position of employee relations director . . . ROBERT W. FOSTER succeeds Ward as controller . . . JAMES M. BROWN to direct corporate services . . . JOHN ECHTERNACH and PIERRE L. RHOEDERER elected vice-presidents of Corning Glass International, S.A., subsidiary of Corning Glass Works . . . JOHN W. GRIFFIN appointed product specialist by the laboratory glassware department . . . ROBERT J. DEAN salesman in the Philadelphia area for the plant equipment department . . . R. BRUCE MARTIN salesman in the Chicago area for the lighting glassware department. . . . HOWARD E. BAHR, assistant director of design for the Glass Works, died May 13. He was 51 and had been with the company in various managerial capacities since 1934.

Clark Equipment Co.

FRED DOLTON named manager of national account sales for the "Michigan" line of construction machinery.

Emhart Mfg. Co.

EVERETT A. COOPER elected vice-president of the firm . . . JAMES E. HARRINGTON appointed domestic sales manager of the Hartford division . . . KENNETH R. GECKLER assigned to the midwest sales office in Columbus, O.

Owens-Illinois Glass Co.

MILES G. BEISHLINE, general manufacturing and engineering manager of the container division, FLOYD M. CANTER, comptroller, SID F. DAVIS, general sales manager of the container division, W. BOYD OWEN, director of personnel administration, and ELLIOTT R. OWENS, director of engineering and development, elected vice-presidents of the company . . . WILLIAM F. SPANGLER named to succeed Canter as comptroller . . . WILLIAM H. BOSHART and WILLIAM WINDUS KNIGHT, SR., given the honorary title of director-emeritus . . . In the container division's new eastern regional sales office, KENNETH O. BOYER named administrative manager, JOSEPH M. MUELLER manager of service and transportation, and ARTHUR L. GEHRING manager of quality control. All will be located in New York . . . OLIVER F. RUNDE, manager of the container division's Fairmount, W. Va., plant, will assume that position at Charleston, W. Va. . . . CARL J. SNYDER, manager at Clarion, Pa., succeeds Runde at Fairmount, and A. W. RENNER, plant engineer at Streator, Ill., will be in charge at Clarion . . . WILLIAM E. McBRIDE, finished products manager at Alton, Ill., becomes manager at Streator, Ill., succeeding MILAN G. KAHL, new division vice-president and regional factories manager . . . DAVID L. EICHER named manager of office methods and procedures for the division . . . Construction of a modern table glassware plant near Pomona, Calif., will begin immediately. The 317,801 sq. ft. facility is to be built by the Libbey Glass Div.

Diamond Alkali Co.

HOWARD E. EVERSON director of research, succeeding Thornton F. Holder who died last month.

Selas Corp. of America

C. WESLEY BERGER recently joined the firm as sales application engineer in the export division.

Minneapolis-Honeywell Regulator Co.

JOHN B. MOXNESS appointed manager of pyrometer supplies for the Brown Instruments Div. . . . JOSEPH F. SULLIVAN, for many years advertising manager of the division, died April 24 at the age of 63. At the time of his death he was advertising production manager of Honeywell's industrial products group.

Foote Mineral Co.

The Caledonia Co., Ltd., of Toronto, Canada, has been appointed executive sales agent in Canada for lithium chemicals produced by Foote.

The Carborundum Co.

The firm and its subsidiary, Pacific Abrasive Supply Co., have moved their offices and stocks to the recently completed $1,500,000 abrasive service center in Los Angeles, Calif.

A Key Chemical for the glass industry since 1890
Wyandotte Soda Ash
We're always looking at the glass industry from your viewpoint: how to get more people to utilize to the fullest extent the wonderful characteristics of glass.
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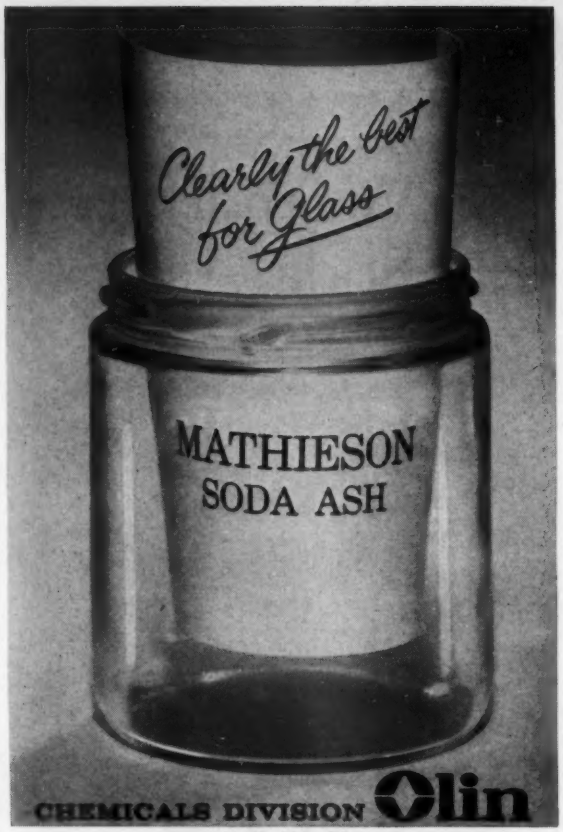
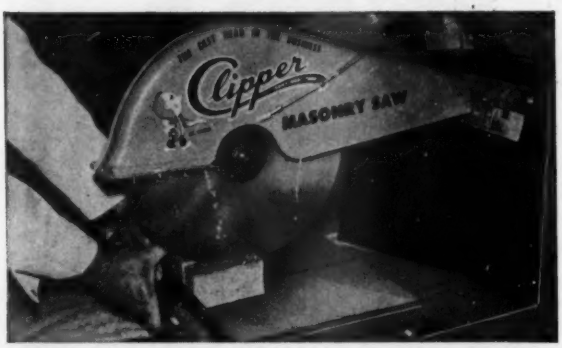


Circle No. 30



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Circle No. 31

Wyandotte Chemicals Corp.

Company officials formally opened the firm's first eastern plant May 19. The new facility, located in Washington, N. J., is manufacturing a broad line of polyether products for expanding markets in the East.

Libbey-Owens-Ford Glass Co.

MELVIN B. BURWELL and GEORGE P. MACNICHOL, III, assistants to the executive vice-president, appointed general director of employee relations and general director of purchasing traffic, respectively, in the firm's production division . . . J. C. DIEHL, now director of purchasing, will continue to head the division . . . JOHN A. FALLER, general traffic manager, named director of traffic and will continue to head that division . . . LOF will continue in 1962 as the largest supplier of General Motors automotive glass requirements under contracts signed with the Fisher Body Div. . . . Approval of a $10,500,000 appropriation by the board of directors has cleared the way for construction of a curved laminated glass fabricating plant near Lathrop, Calif. The new facility, providing 360,000 sq. ft. of floor space, is scheduled for operation by early 1962.

Metal & Thermit Corp.

DAVID B. ORDEN named manager of Latin American operations for the International division. He will have his headquarters in New York City.

Harbison-Walker Refractories Co.

P. C. MITCHELL, vice-president, mining, and J. C. WILLEY, assistant to the president and managing director of the firm's Peruvian subsidiary, have been elected to the board of directors.

International Resistance Co.

JAMES C. ALEMANNI and DONALD E. KAPLAN have joined the engineering staff . . . LEWIS L. PARSON to head the firm's distributor division sales in the Chicago area.

Kahle Engineering Co.

WILLIAM T. ENGEL appointed chief engineer in charge of the engineering and design department.

Kaiser Refractories & Chemicals Div.

FRANK M. CASHIN elected president of the division . . . A licensing agreement with Ceramica Olivos S. A., Buenos Aires, Argentina, for the manufacture of refractory specialty products. All products will be manufactured under Kaiser trademarks, formulae, and quality control methods.

Lynch Corp.

ROBERT C. COBLENTZ, inventor of the Coblentz Dry Air Systems, has joined the company at the same time that Lynch has acquired the Systems from Lovell Mfg. Co.

Stauffer Chemical Co.

Announcement has been made of purchase of the special fluorides producing facilities of Aluminum Co. of America. Distribution of the new fluoride products will be handled through the industrial chemical division sales offices in New York, Philadelphia, Chicago, and Atlanta.

Chas. Taylor & Sons Co.

ROBERT S. MOORE appointed sales representative . . . Societe Belge du Titane, S. A., Brussels, Belgium, named exclusive distributor of the company's sillimanite and zircon special refractories for the glass industries in six European Common Market countries and Switzerland.

Allied Chemical Corp.

DR. EDWARD F. BOOTH, JR., named director of research for Solvay Process Div. . . . Construction for a 50 per cent expansion in hydrofluoric acid capacity at the General Chemical Div. is scheduled for completion July 1.

Brockway Glass Co.

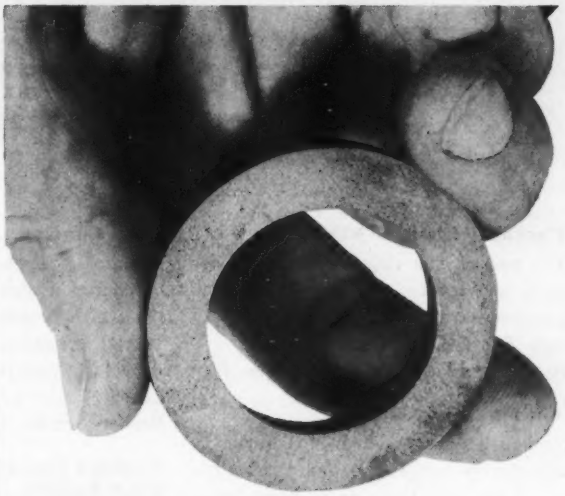
LOUIS GAYNER director of operations at the new Rosemount, Minn., plant, which began production May 1.

Hermetite Corp.

PAUL X. KERWIN named plant manager . . . MORTON LADGE, president, predicted in a speech before a group of security analysts that the glass-to-metal seals industry would soon reach a sales volume of $50 million . . . Consolidation of the firm's two research and development units will begin at the new Avon, Mass., plant.

Pittsburgh Plate Glass Co.

JOHN W. BAGGOT appointed chief engineer for the paint and brush division . . . In the recently created traffic and transportation department, JAMES C. HIGGINS named manager of chemical rates, H. BRUCE REAVES, JR., manager of glass and paint rates, JAMES E. WEAVER, manager of transportation, EDWARD E. CHANEY, manager of routing, G. JOHN LAMBILLOTTE, manager of planning, and WARREN W. CLARK, office manager . . . At the Harmar Township, Pa., research laboratory, J. W. MORRIS appointed to the newly-created position of programming manager, M. N. ZEOLLA, assistant manager of programming, C. R. WARD, assistant manager of the melting and forming division, and DR. FRANK H. GILLERY, group leader in the glass center . . . DWIGHT R. MEANS, age 63, former president and chief executive officer of Pittsburgh Plate International, S.A., died April 3 . . . FRANK G. MOORE, retired general traffic manager of Columbia-Southern Chemical Corp., a subsidiary of PPG, died April 29 at the age of 65 . . . According to an order from the Fisher Body Div. of General Motors Corp. to produce a portion of the glass for 1962 auto models PPG will supply an undisclosed percentage of the nation's largest auto maker's requirements for the year.



Thimbles Last 9 Times Longer with Colmonoy Inserts

Cast iron plunger guide rings (thimbles) can be made to last at least nine times longer by protecting them with inserts of cast Colmonoy No. 4. Colmonoy thimble inserts are available in fifteen stock sizes, and in special sizes to order. They are quality castings and are X-ray inspected. Easily machined with carbide tools, they are press-fitted or silver soldered in place. Besides providing long trouble-free operation, they produce more parts to correct size. Ask for Colmonoy Engineering Data Sheet No. 42A.

Colmonoy hard-surfacing alloys are saving the costs of replacing thimbles, neck rings, plungers, blowheads, moulds, and many other glass machinery parts, by making existing parts last much longer than ever before. Find out what Colmonoy alloys can do for your equipment. Write for more information today.

The plunger shown, mate to the Colmonoy-protected thimble, has been hard-surfaced with Colmonoy No. 4 also. The Colmonoy Spraywelder, a powder metal spraying unit, was used to produce the sprayed-and-fused overlay. The two parts, with similar long wearing surfaces, provide the ultimate in wear resistance.

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Circle No. 32

NEW EQUIPMENT AND SUPPLIES

Portable Electric Vibrator

For moving materials from bins, hoppers, and trucks; eliminates need for one type of vibrator for each application. *The Cleveland Vibrator Co.*

Reader Service Card: Circle No. 57

Natural Diamond Grit

Said to be stronger than any diamond abrasive in use today, and especially suited for operations where heavy cutting or grinding pressures are necessary. *Diamond Tool Research Co., Inc.*

Reader Service Card: Circle No. 58

Protective Masks

For protection against nontoxic dusts and hazards of sprays. Refills are packaged in self-dispensing container; replaceable cotton filters cost two cents each. *General Scientific Equipment Co.*

Reader Service Card: Circle No. 59

Gas and Air Mixers

Accurately proportion gas and air and deliver mixture under pressure to one or more burners; wide range of adjustment permits setting for constant ration operation with oxidizing, reducing, or neutral flame. *Eclipse Fuel Engineering Co.*

Reader Service Card: Circle No. 60

Sun Control Product

Liquid material is flow-coated on existing windows and glass areas; controls infrared, ultraviolet and visible light rays; available in 11 tints; odorless; nontoxic. *National Glass Tinting Co.*

Reader Service Card: Circle No. 61

Centerless Grinder

Can grind multidiameter parts and balls from glass, plastic, and steel; features highspeed automatic cycling with positive repeating action as well as manual operation. *Royal Master Grinders, Inc.*

Reader Service Card: Circle No. 62

Bandsaw Machine

Small bench type, with 14-in. diameter wheel bandsaw which takes a 7-ft. 7-in. long diamond blade; cuts such materials as special glasses, quartz, silicon, carbide, etc. *Dia-Chrome Co.*

Reader Service Card: Circle No. 63

Roof Coating

Combines maximum protection from deterioration with heat reflective qualities which cool building interiors 15°F in warm weather. Available in white or colors. *Superior Paint & Varnish Corp.*

Reader Service Card: Circle No. 64

Position Control for Glass Cutting

Automatically positions cutting heads for glass cutting machines to within 0.01 in. over range of 72 in. at speeds up to 400 in. per hour. *Seneca Falls Machine Co.*

Reader Service Card: Circle No. 65

Portable Drill Unit

Designed for drilling holes from 2 in. to 6¼ in. in diameter in masonry and concrete. Basic unit has 2 hp motor mounted on portable tubular steel cradle with flexible shaft and foot switch. *Clipper Mfg. Co.*

Reader Service Card: Circle No. 66

Leasing Plan

Enables companies to use needed equipment, machinery and fixtures without capital investment. At end of lease, equipment may be returned, or leased for additional period; options to purchase equipment are available. *National Acceptance Co.*

Reader Service Card: Circle No. 67

CATALOGS RECEIVED

Masonry and concrete cutting equipment. (4 pages). Also features chart for refractories and building materials and blade comparison chart. *Eveready BrikSaw Co.*

Reader Service Card: Circle No. 68

Flow meter engineering handbook (170 pages). Includes schematic diagrams, graphs, charts, tables, and other data, with separate chapters on steam, liquid, and gas flow calculations; all data necessary to calculate or check an orifice plate installation. Three solutions to a flow problem are outlined in each chapter. Price $7.50. Order direct from company. *Brown Instruments Div.*

Reader Service Card: Circle No. 69

Diamond-coated steel tools (14 pages). Discusses industrial applications, particularly in the manufacture of hard plastics. Description of tools and a price list. *Dia-Chrome Co.*

Reader Service Card: Circle No. 70

Temperature recorder (12 pages). Platinum resistance sensors for temperatures from –32°F to over 2000°F, with deviations of 0.01°F. Recording accuracy said to be 10 to 100 times faster than possible with conventional slide wire recorders. *Brush Instruments, division of Clevite Corp.*

Reader Service Card: Circle No. 71

Glass-polishing oxides (4 pages). Soft cerium oxide which can be used without change in present production setups; lists general characteristics, composition, and applications. *Vitro Chemical Co.*

Reader Service Card: Circle No. 72

New laboratory ware (2 pages.) Describes threaded glass needle valve, stopcock lock, and heavy-duty high-speed centrifuge separator. *Fischer & Porter Co.*

Reader Service Card: Circle No. 73

Dial indicators (8 pages). Describes design and use of cabinet dial and pillar dial indicators. *Fairbanks, Morse & Co.*

Reader Service Card: Circle No. 74

Direct reading dials (4 pages). Equipment showing weights on direct reading dials; used where printed weights are not required. *Streeter-Amet Co.*

Reader Service Card: Circle No. 75

Combustion controllers (8 pages). Continuously detect and automatically correct changes in furnace pressure by adjusting dampers. *North American Mfg. Co.*

Reader Service Card: Circle No. 76

Sight flow indicators (2 pages). For indicating passage of any product which flows through pipelines. Bulletin shows 11 styles, materials of construction, sizes, pressure, and temperature ratings, etc. *OPW-Jordan Corp.*

Reader Service Card: Circle No. 77

INVENTIONS AND INVENTORS

Glass Wool and Fiber

Apparatus for Producing Continuous Glass Fibers. Patent No. 2,962,755. Filed Jan. 2, 1957. Issued Dec. 6, 1960. One drawing; not reproduced. Assigned to Johns-Manville Fiber Glass Div. by Jesse H. Plummer.

The purpose of this invention is to shield the fiber attenuation zone from the radiant energy produced by the wall of the melting chamber through which the molten glass streams are exuded. This is accomplished by placing a heat-reflective shield between the wall of the melting chamber and the ends of the tips or orifices through which the glass is exuded. Thus, the glass cones which are formed at the termini of the tips from which the fibers are produced are shielded from radiant energy from the melting chamber.

The radiation shield is a small tubular or multi-sided member positioned in surrounding coaxial relationship with the tips or orifices through which the molten glass streams are exuded to shield the termini thereof from the radiant energy of the adjacent melting chamber wall.

The radiation shield also provides an extended surface area through which heat by conduction from the melting chamber to the nozzle is reduced.

If the zone of fiber attenuation is not protected from intense heat radiation, the smaller fibers are remelted and broken, causing machine breakdown.

There were 17 claims and 13 references cited in this patent.

Apparatus for Forming Mineral Fibers and the Like. Patent No. 2,882,552. Filed Apr. 29, 1955. Issued Apr. 21, 1959. No sheets of drawings; none reproduced. Assigned to Midwest Insulations, Inc., by Richard M. Downey.

An apparatus for fabricating mineral wool comprising a rotor having a forwardly exposed slag-receiving face, means for producing an enveloping stream of fluid around the periphery of said rotor forwardly and axially of said rotor, fluid-deflecting means disposed adjacent the rotor periphery for directing a portion of said stream of fluid radially inwardly in front of said rotor, and means for delivering a stream of molten slag in front of said rotor face, said deflected stream of fluid acting on said slag stream to direct it onto said rotor face from which said slag is discharged in the form of fibrous material.

Process of Producing Mats of Glass Fibers. Patent No. 2,863,176. Filed April 7, 1954. Issued Dec. 9, 1958. No sheets of drawings; none reproduced. Assigned to L. O. F. Glass Fibers Co. by Dominick Labino.

A method for the production of a blown fibrous product is described, which method in substance effects an orientation of the fibers and at the same time achieves an improved dispersion of the fibers to permit the attainment of products of greater surface area with a given weight of the fibers.

These are attained in a highly efficient manner by introducing into the gaseous blast which attenuates the heat softenable filaments and carries the same to the collecting means, the vapors of a volatilizable inorganic salt and then collecting the blown fibers. The effect of the introduction of the vapors of the salt into the gaseous blast carrying the fibers is both to increase the dispersion of the fibers in the blast and to orient the fibers somewhat so that the ends thereof lie substantially in the plane of the finished mat or sheet and do not substantially protrude therefrom.

There were 14 claims and the following references cited in this patent.

United States Patents

2,184,320, Simpson, Dec. 26, 1939; 2,189,840, Simison et al., Feb. 13, 1940; 2,318,243, McClure, May 4, 1943; 2,331,944, Pazsiczky et al., Oct. 19, 1943; 2,348,182, Slayter, May 2, 1944; 2,647,851, Schwartz, Aug. 4, 1953.

Apparatus Used in the Production of Glass Fibers. Patent No. 2,949,633. Filed Dec. 31, 1956. Issued Aug. 23, 1960. Two sheets of drawings; none reproduced. Assigned to L.O.F. Glass Fibers Co. by Warren Wendell Drummond, William B. Hullhorst, and Jesse H. Plummer.

The purpose of this invention is to reduce the radiation from the bottom of the melting chamber to the fiber forming area and thereby increase, as well as render more uniform, the cone cooling rate. This is accomplished by placing a heat radiation shield between the bottom of the melting chamber and the ends of the tips through which the glass is exuded from the chamber. The radiation shield is a thin plate member fabricated of a material which has high heat reflectivity and low heat emissivity. The shield acts to reflect heat back into the glass melting chamber and at the same time reduces radiation to the cone area.

There were 16 claims and 13 references cited in this patent.

Apparatus for Manufacture of Fibrous Glass. Patent No. 2,947,028. Filed Nov. 19, 1954. Issued Aug. 2, 1960. Three sheets of drawings; none reproduced. Assigned to Owens Corning Fiberglas Corp. by Games Slayter.

According to the invention, glass, as it is flowed into the stream from which the fiber is attenuated, is strung out into a multiplicity of minute streamlets, each of exceedingly small diameter, and by this operation the glass is hydraulically worked so as to be conditioned to provide the desired improved physical properties in the fiber. This working of the glass into minute streams causes all portions of the glass to be homogenized or strung out into fine stria so that any aggregates of molecules are oriented so that they all extend in substantially the same direction and thus impart added strength to the fibers.

Here this is achieved by passing the molten glass through a filter disc or plate having a plurality of fine diameter holes or openings. The small streams of glass so formed are then directed immediately into the forming cone from which fibrous glass is produced.

There were 3 claims and 16 references cited in this patent.

(*Continued on page* 363)

CURRENT STATISTICAL POSITION OF GLASS

Employment in the glass industry during February, 1961, was as follows: *Flat Glass*: a preliminary figure of 23,200 for February, 1961, indicates a decrease of 8.3 per cent under the adjusted figure of 25,300 for January, 1961. *Glass and Glassware, Pressed and Blown*: an increase of 2.6 per cent is shown by the preliminary figure of 84,900 reported for February, 1961, when compared with the adjusted figure of 82,700 reported for January, 1961. *Glass Products Made of Purchased Glass*: the preliminary figure of 13,200 given for February, 1961, is 1.5 per cent over the adjusted figure of 13,000 reported for January, 1961.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers

	March, 1961
Food	2,161,000
Medicinal and Health Supplies	1,968,000
Chemical, Household and Industrial	1,223,000
Toiletries and Cosmetics	1,174,000
Beverage, Returnable	850,000
Beverage, Nonreturnable	218,000
Beer, Returnable	489,000
Beer, Nonreturnable	1,849,000
Liquor	957,000
Wine	465,000
Subtotal (Narrow)	11,354,000

Wide Mouth Containers

Food	*4,809,000
Medicinal and Health Supplies	547,000
Chemical, Household and Industrial	211,000
Toiletries and Cosmetics	340,000
Dairy Products	201,000
Subtotal (Wide)	*6,108,000
Total Domestic	17,462,000
Export Shipments	141,000
TOTAL SHIPMENTS	*17,603,000

* This figure includes Fruit Jars, Jelly Glasses, and Packers' Tumblers.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production March 1961	Stocks March 1961
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics.	Narrow Neck	5,505,000	6,217,000
	Wide Mouth	*5,144,000	5,703,000
Beverage, Returnable		884,000	2,641,000
Beverage Nonreturnable		239,000	393,000
Beer, Returnable		410,000	597,000
Beer, Nonreturnable		1,504,000	1,410,000
Liquor		938,000	1,524,000
Wine		369,000	647,000
Dairy Products		168,000	278,000
TOTAL		*15,161,000	*19,410,000

* This figure includes Fruit Jars, Jelly Glasses, and Packers' Tumblers.

Payrolls in the glass industry during February, 1961, were as follows: *Flat Glass*: a decrease of 9.6 per cent is shown in the preliminary $12,271,159.99 given for February, 1961, when compared with January's $13,596,776.35. *Glass and Glassware, Pressed and Blown*: an increase of 3.6 per cent is shown in the preliminary $34,517,401.61 given for February, 1961, when compared with the previous month's adjusted $33,289,702.39. *Glass Products Made of Purchased Glass*: a preliminary figure of $4,271,939.36 was reported for February, 1961. This is an increase of 2.8 per cent when compared with the adjusted figure of $4,163,276.39 for January.

Glass Container Production based on figures released by the Bureau of the Census, Industry Division, was 15,161,000 gross during March, 1961. This is an increase of 21.1 per cent over the previous month's production figure of 12,520,000 (revised) gross. During March, 1960, glass container production was 13,747,000 gross, or 9.3 per cent less than the March, 1961, figure. At the end of the first three months of 1961, glass container manufacturers have produced a preliminary total of 39,968,000 gross. This is 0.6 per cent more than the 39,707,000 gross produced during the same period in 1960.

Glass Container Shipments during March, 1961, came to 17,603,000 gross, an increase of 55.7 per cent over the February figure of 11,300,000 gross. Shipments during March, 1960, amounted to 13,136,000 gross, or 25.3 per cent less than March, 1961. At the end of the first three months of 1961, shipments have reached a preliminary total of 40,497,000 gross which is 12.8 per cent more than the 35,864,000 gross shipped during the same period of the previous year.

Stocks on hand at the end of March, 1961, came to 19,410,000 gross. This is 12.4 per cent less than the 21,830,000 gross on hand at the end of February, 1961, and 7.6 per cent less than the 21,028,000 gross on hand at the end of March, 1960.

INVENTIONS AND INVENTORS

(*Continued from page* 361)

Glass Fiber Forming Machine. Patent No. 2,960,723. Filed July 15, 1953. Issued November 22, 1960. One drawing; not reproduced. By Howard John Stark.

In accordance with this invention, powdered or finely ground glass or powdered chemical comprising glass formulation are heated in an electrically heated ceramic sleeve to a molten state. The molten glass composition is extended through an orifice in the ceramic sleeve and pulled through a dimensional orifice to form a filament, which is then sized or coated with a suitable substance, such as light petroleum oil or the like.

The invention utilizes an economical apparatus wherein a melting furnace is eliminated and the molten glass is extruded from a heated ceramic sleeve. The apparatus does not incorporate any expensive noble metal orifices or any auxiliary devices to maintain the glass fiber at a constant temperature after being extruded from the ceramic sleeve. Also, the ceramic sleeve is constructed of such common substance, readily obtainable and manufactured, that they can be replaced whenever the opening of the sleeve becomes enlarged by the constant erosion of the flowing glass.

By extruding the glass through the heated ceramic sleeve, the temperature of the molten glass can be easily maintained relatively high for a longer period than previously known, since the extruding pressure keeps the glass moving at a rapid rate after leaving the ceramic sleeve orifice. Further, the ceramic sleeve orifice is of a sufficiently large diameter that clogging of the glass therein would not result after an appreciable period of use and of such large diameter that rapid cooling of the glass will not occur before being finally formed by the dimensional orifice.

The invention provides a simple unit which may utilize either powdered or finely ground new or old glass or powdered chemicals comprising glass formulations. Consequently, glass fibers are produced at a low cost by using simple equipment and avoiding expensive platinum or its alloys.

There were 2 claims and the following references.

United States Patents

946,179, Weiskopf, Jan. 11, 1910; 2,229,489, Barnard, Jan. 21, 1941; 2,255,236, Willis, Sept. 9, 1941; 2,392,805, Biefeld, Jan. 15, 1946; 2,566,252, Tooley et al., Aug. 28, 1951; 2,585,496, Powell, Feb. 12, 1952; and 2,621,444, Schuller, Dec. 16, 1952.

Method of Applying Wax to Strands of Glass Fibers. Patent No. 2,946,698. Filed October 20, 1958. Issued July 26, 1960. One drawing; not reproduced. Assigned to Pittsburgh Plate Glass Company by Wayne A. Brunnick and Clarence H. Helbing.

At high speeds of attenuation found in the production of continuous filament strands (5,000 to 20,000 feet per minute), it is extremely difficult to get a sufficient supply of wax on the individual filaments and strands during the attenuation operation.

In accordance with the present invention it has been found that a glass fiber strand or yarn wound in layers on a perforated tube can be uniformly impregnated with wax by first drying the yarn package and then forcing the wax to flow through the glass yarn and then through the openings in the tube by a differential in pressure between the exterior and interior layers of yarn. The greater pressure is at the exterior layer, and this differential in pressure causes the wax to flow evenly from all points on the surface of the yarn package into the perforated tube surface and then through the opening in the tube from where it is carried away. By forcing the wax to flow from the outer surface of the yarn package to the inner surface, it has been found that channeling does not occur.

There were 3 claims and the following references.

United States Patents

2,031,094, Brandwood, Feb. 18, 1936; 2,272,588, Simison, Feb. 10, 1942; and 2,340,048, Dykeman, Jan. 25, 1944.

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